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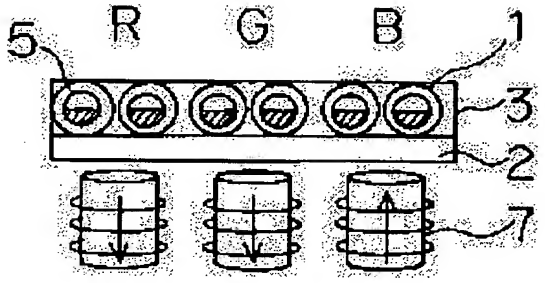
(54) COLOR DISPLAY METHOD, DISPLAY SHEET AND DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To perform color display by easy control without complicating the structure by using a method for image display to control particles to vary the reflectance by the pixel unit.
SOLUTION: A display layer 3 is formed by preparing three kinds of color microcapsules 1 each colored into one of R, G, B which encapsulate rotating particles 5 colored into two colors of white and black and by disposing the microcapsules 1 at random or by periodically varying the kinds of the microcapsules by the pixel unit on a supporting body 2. When the microcapsules 1 are disposed at random, the microcapsules 1 of R, G, B are prepared to have different rotation thresholds for the respective encapsulated rotating particles 5 and the objective colors are displayed by controlling the direction and intensity of the magnetic field to be applied. When the microcapsules are periodically disposed into the pixel units, the rotation state of the rotating particles 5 in the color microcapsules of R, G, B are controlled by the pixel unit to display the objective colors.



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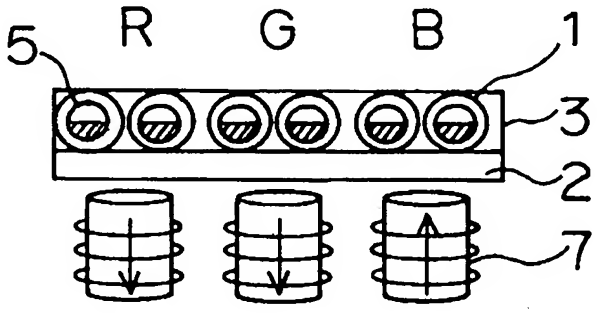
(54)【発明の名称】　カラー表示方法、表示シートおよび表示装置

(57)【要約】
【課題】　粒子を制御して画素単位で光反射率を変化させる画像表示方法を用いて、構成を複雑化することなく簡単な制御でカラー表示を行う。
【解決手段】　白／黒の２色に色分けされた回転粒子５を内包し、Ｒ、Ｇ、Ｂのいずれかに着色された３種類の着色マイクロカプセル１をランダムに、または画素単位に周期的に種類を替えて支持体２上に配置し、表示層３を形成する。ランダムに配置する場合には、Ｒ、Ｇ、Ｂの各着色マイクロカプセル１は、それぞれ内包する回転粒子５の回転しきい値が異なるよう構成され、印加する磁場の向きと大きさにより目的の色を表示する。画素単位に周期的に配置する場合には、画素単位でＲ、Ｇ、Ｂの各着色マイクロカプセル１内の回転粒子５の回転状態を制御して目的の色を表示する。



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【特許請求の範囲】

【請求項１】　表面色の異なる複数種類の着色マイクロカプセルを配列し、各着色マイクロカプセルに内包された粒子の状態を制御して着色マイクロカプセルの光学特性を変化させることにより、画像をカラー表示することを特徴とするカラー表示方法。

【請求項２】　請求項１記載のカラー表示方法において、前記着色マイクロカプセルの表面色が赤、緑、青の３種類であることを特徴とするカラー表示方法。

【請求項３】　請求項１記載のカラー表示方法において、前記着色マイクロカプセルの光学特性を変化させる制御しきい値をその種類に応じて異なるように設定し、複数種類の着色マイクロカプセルをランダムに配列して、選択的に目的の種類の着色マイクロカプセルの光学特性を変化させて、画像をカラー表示することを特徴とするカラー表示方法。

【請求項４】　請求項１記載のカラー表示方法において、前記複数種類の着色マイクロカプセルを画素単位に周期的に種類が異なるように配列し、画素単位で着色マイクロカプセルの光学特性を変化させて、画像をカラー表示することを特徴とするカラー表示方法。

【請求項５】　請求項１記載のカラー表示方法において、前記着色マイクロカプセルが光反射性と光吸収性の２色に色分けされた粒子を回転可能に内包し、この粒子の回転状態により着色マイクロカプセルの光学特性を変化させることを特徴とするカラー表示方法。

【請求項６】　請求項５記載のカラー表示方法において、前記着色マイクロカプセルが磁気的作用により回転可能な粒子を内包することを特徴とするカラー表示方法。

【請求項７】　請求項５記載のカラー表示方法において、前記着色マイクロカプセルが電気的作用により回転可能な粒子を内包することを特徴とするカラー表示方法。

【請求項８】　内包する粒子の状態により光学特性が変化する表面色の異なる複数種類の着色マイクロカプセルが配列された表示層を備えたことを特徴とする表示シート。

【請求項９】　請求項８記載の表示シートにおいて、前記着色マイクロカプセルの表面色が赤、緑、青の３種類であることを特徴とする表示シート。

【請求項１０】　請求項８記載の表示シートにおいて、前記着色マイクロカプセルの光学特性を変化させる制御しきい値が種類に応じて異なり、複数種類の着色マイクロカプセルがランダムに配列されていることを特徴とする表示シート。

【請求項１１】　請求項８記載の表示シートにおいて、前記複数種類の着色マイクロカプセルが画素単位に周期的に種類を変えて配列されていることを特徴とする表示シート。

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【請求項１２】　請求項８記載の表示シートにおいて、前記着色マイクロカプセルが光反射性と光吸収性の２色に色分けされた粒子を回転可能に内包し、この粒子の回転状態が磁気的手段または電気的手段により制御可能であることを特徴とする表示シート。

【請求項１３】　内包する粒子の状態により光学特性が変化する表面色の異なる複数種類の着色マイクロカプセルが配列された表示層と、

前記表示層の画素単位に着色マイクロカプセル内の粒子状態を制御して画像の書込みまたは消去を行う入力手段とを備えたことを特徴とする表示装置。

【請求項１４】　請求項１３記載の表示装置において、前記着色マイクロカプセルの光学特性を変化させる制御しきい値が種類に応じて異なり、複数種類の着色マイクロカプセルがランダムに配列されていることを特徴とする表示装置。

【請求項１５】　請求項１３記載の表示装置において、前記複数種類の着色マイクロカプセルが画素単位に周期的に種類を変えて配列されていることを特徴とする表示装置。

【請求項１６】　請求項１３記載の表示装置において、前記着色マイクロカプセルの光学特性が、内包する粒子の回転状態により変化することを特徴とする表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、図形や文字等の画像をカラー表示する表示技術に関する。

【０００２】

【従来の技術】情報を表示する表示装置としては、その表示品質、経済性の観点から現在でもＣＲＴが主流であるが、小型、軽量、低消費電力などを考慮して、種々のフラットパネルディスプレイが研究開発され、実用化されている。このようなディスプレイとしては、プラズマディスプレイ（ＰＤＰ）、エレクトロルミネッセンスディスプレイ（ＥＬＤ）、蛍光表示管（ＶＦＤ）、発光ダイオード（ＬＥＤ）などの発光型ディスプレイおよび液晶ディスプレイ（ＬＣＤ）などの受光型ディスプレイが挙げられる。

【０００３】これらが主に適用されるＯＡ分野においては、これまで印刷物という媒体に慣れ親しんできたため、ちらつき等による目に疲労の少ないディスプレイが望まれているが、ＣＲＴを始めとする発光型ディスプレイではこの点を解決することは難しい。その点、受光型のＬＣＤは有利であり、低消費電力などの利点もあるが、視野角依存性、温度依存性などの特有のデメリットもあるのが実情である。

【０００４】そこで、受光型ディスプレイでも、マイクロカプセルからなる画像表示層を有し、磁気的または電気的作用により画素単位で光反射率を変化させることにより画像表示を行う方式、例えば、電気泳動ディスプレ

イ、磁気泳動ディスプレイ、分散粒子配向型ディスプレイ、電気的または磁気的手段を用いた回転粒子型ディスプレイなどが提案されてきた。ここで、電気泳動ディスプレイは、光吸収性または光反射性の微粒子を分散した液体を内包するマイクロカプセルによって画像表示層を形成し、マイクロカプセルにおいて、固液界面での電荷の授受により電気二重層が形成され、微粒子は正または負に帯電し、これに電界を加えると微粒子は電界の方向に応じて泳動することを利用して、各画素ごとに表示層上部の明暗のコントラストを付けることで画像を表示するものである。

【０００５】また磁気泳動ディスプレイは、光吸収性の磁性体微粒子と光反射性の非磁性体微粒子を分散した液体を内包するマイクロカプセルによって画像表示層を形成し、磁界を加えるとマイクロカプセルにおいて磁性体微粒子が吸引されることを利用して、各画素ごとに表示層上部の明暗のコントラストを付けることで画像を表示するものである。

【０００６】また分散粒子配向型ディスプレイは、偏平性などの形状異方性をもつ磁性体粒子の分散液を内包するマイクロカプセルによって画像表示層を形成し、磁界を加えると形状異方性をもつ磁性体粒子の向きに応じた光の反射、散乱、吸収が起こることを利用して、各画素ごとに表示層上部の明暗のコントラストを付けることで画像を表示するものである。

【０００７】さらに、回転粒子型ディスプレイは、半球ずつに色分けされた球状回転粒子を流動体とともに内包するマイクロカプセルによって画像表示層を形成し、磁気的または電気的手段などによってマイクロカプセル内の球状回転粒子を回転制御して、各画素ごとに表示層上部の明暗のコントラストを付けることにより、画像を表示するものである。

【０００８】

【発明が解決しようとする課題】しかしながら、これらのディスプレイは、現状では白黒の単色表示だけであり、ＣＲＴやＬＣＤに比べてカラー表示が実用化されていないという問題があった。このため、表示層上に２色以上のカラーフィルタを配置してカラー表示を行うものが提案されているが（特開平１０－２３２６３０号公報）、これはカラーフィルタを用いることによるコストアップが考えられるとともに、カラーフィルタ層が加わることにより層構成が複雑になり、製造工程が増えるだけでなく、明るさ、コントラストなどの表示特性にも影響し、表示層上部からの書き込み／消去の際にも厚みが増すため不利となる。

【０００９】本発明は、上記従来技術の問題点に対処してなされたもので、磁気的または電気的作用により画素単位で光反射率を変化させる画像表示方法を用いて、構成を複雑化することなく簡単な制御でカラー表示を行うことができるカラー表示方法、およびこのカラー表示方法を用いた表示シート並びに表示装置を提供することを目的とする。

【００１０】

【課題を解決するための手段】すなわち、請求項１の発明のカラー表示方法は、表面色の異なる複数種類の着色マイクロカプセルを配列し、各着色マイクロカプセルに内包された粒子の状態を制御して着色マイクロカプセルの光学特性を変化させることにより、画像をカラー表示することを特徴とする。

【００１１】本発明のカラー表示方法においては、着色マイクロカプセルの光反射率が内包する粒子の状態により変化することで、着色マイクロカプセルの表面色を表示させたり黒く表示させたりすることが可能となり、画像のカラー表示が可能となる。これにより、受光型のため目の疲れが少なく、かつＬＣＤよりも広視野角のカラー表示が比較的簡単な構成で低コストで実現可能となる。

【００１２】請求項２の発明は、請求項１のカラー表示方法において、着色マイクロカプセルの表面色が赤、緑、青の３種類であることを特徴とする。これにより、赤、緑、青、黒の組み合わせで、フルカラーの画像表示が可能となる。

【００１３】請求項３の発明は、請求項１のカラー表示方法において、着色マイクロカプセルの光学特性を変化させる制御しきい値をその種類に応じて異なるように設定し、複数種類の着色マイクロカプセルをランダムに配列して、選択的に目的の種類の着色マイクロカプセルの光学特性を変化させて、画像をカラー表示することを特徴とする。この発明においては、色の異なる着色マイクロカプセルの配列が容易で、表示部と書き込み／消去を行う入力部との精密な位置合わせを要することなく、着色マイクロカプセルに印加する磁気的作用または電気的作用の大きさ変えることで、カラー表示が可能となる。

【００１４】請求項４の発明は、請求項１のカラー表示方法において、複数種類の着色マイクロカプセルを画素単位に周期的に種類が異なるように配列し、画素単位で着色マイクロカプセルの光学特性を変化させて、画像をカラー表示することを特徴とする。この発明においては、着色マイクロカプセルの光学特性を変化させる制御しきい値をその種類に応じて変える必要がなく、画素単位の制御により容易にカラー表示が可能となる。

【００１５】請求項５の発明は、請求項１のカラー表示方法において、着色マイクロカプセルが光反射性と光吸収性の２色に色分けされた粒子を回転可能に内包し、この粒子の回転状態により着色マイクロカプセルの光学特性を変化させることを特徴とする。これにより、回転粒子の光反射性の面を表側に向けた場合には、この回転粒子を内包した着色マイクロカプセルの表面色が表示され、光吸収性の面を表側に向けた場合には、黒が表示されて、画像のカラー表示が可能となる。

【００１６】請求項６の発明は、請求項５のカラー表示方法において、着色マイクロカプセルが磁気的作用により回転可能な粒子を内包することを特徴とする。これにより、磁気ヘッド等の磁気的手段により粒子の回転状態を制御することが可能となり、簡単な構成で視認性の優れたカラー表示が実現される。

【００１７】請求項７の発明は、請求項５のカラー表示方法において、着色マイクロカプセルが電気的作用により回転可能な粒子を内包することを特徴とする。これにより、画素電極による電界印加駆動方式を用いて容易に着色マイクロカプセル内の粒子の回転状態を制御することができ、高解像度のカラー表示が実現される。

【００１８】請求項８の発明の表示シートは、内包する粒子の状態により光学特性が変化する表面色の異なる複数種類の着色マイクロカプセルが配列された表示層を備えたことを特徴とする。この発明においては、着色マイクロカプセル内の粒子の状態を制御して、目的の着色マイクロカプセルの光学特性を変化させることにより、容易にカラーで画像を表示することが可能となる。また表示シートとして構成が簡単なため、紙のように薄くてフレキシブルな広視野角のカラー表示シートが得られ、低コストで作製可能となる。

【００１９】請求項９の発明は、請求項８の表示シートにおいて、着色マイクロカプセルの表面色が赤、緑、青の３種類であることを特徴とする。これにより、赤、緑、青、黒の組み合わせで、フルカラーの画像表示が可能となる。

【００２０】請求項１０の発明は、請求項８の表示シートにおいて、着色マイクロカプセルの光学特性を変化させる制御しきい値が種類に応じて異なり、複数種類の着色マイクロカプセルがランダムに配列されていることを特徴とする。この発明においては、色の異なる着色マイクロカプセルの配列が容易でであるとともに、表示シートと書き込み／消去を行う入力手段との精密な位置合わせを要することなく、着色マイクロカプセルに印加する磁気的作用または電気的作用の大きさ変えることで、カラー表示が可能となる。

【００２１】請求項１１の発明は、請求項８の表示シートにおいて、複数種類の着色マイクロカプセルが画素単位に周期的に種類を変えて配列されていることを特徴とする。この発明においては、着色マイクロカプセルの光学特性を変化させる制御しきい値をその種類に応じて変える必要がなく、画素単位の制御により容易にカラー表示が可能となる。

【００２２】請求項１２の発明は、請求項８の表示シートにおいて、着色マイクロカプセルが光反射性と光吸収性の２色に色分けされた粒子を回転可能に内包し、この粒子の回転状態が磁気的手段または電気的手段により制御可能であることを特徴とする。この発明においては、磁気ヘッド等の磁気的手段により、または画素電極等の電気的手段により、表示シートの着色マイクロカプセル内の粒子の回転状態を制御することができ、回転粒子の光反射性の面を表側に向けた場合には、この回転粒子を内包した着色マイクロカプセルの表面色が表示され、光吸収性の面を表側に向けた場合には、黒が表示されて、画像のカラー表示が可能となる。

【００２３】請求項１３の発明の表示装置は、内包する粒子の状態により光学特性が変化する表面色の異なる複数種類の着色マイクロカプセルが配列された表示層と、表示層の画素単位に着色マイクロカプセル内の粒子状態を制御して画像の書込みまたは消去を行う入力手段とを備えたことを特徴とする。この発明においては、入力手段が画素単位に表示層の着色マイクロカプセル内の粒子状態を制御することで、着色マイクロカプセルの表面色か黒かの表示選択がなされ、容易に画像のカラー表示ないし消去が行われる。

【００２４】請求項１４の発明は、請求項１３の表示装置において、着色マイクロカプセルの光学特性を変化させる制御しきい値が種類に応じて異なり、複数種類の着色マイクロカプセルがランダムに配列されていることを特徴とする。この発明においては、色の異なる着色マイクロカプセルの配列が容易であり、着色マイクロカプセルに印加する磁気的作用または電気的作用の大きさ変えることで、カラー表示が可能となる。

【００２５】請求項１５の発明は、請求項１３の表示装置において、複数種類の着色マイクロカプセルが画素単位に周期的に種類を変えて配列されていることを特徴とする。この発明においては、着色マイクロカプセルの光学特性を変化させる制御しきい値をその種類に応じて変える必要がなく、画素単位の制御により容易にカラー表示が可能となる。

【００２６】請求項１６の発明は、請求項１３の表示装置において、着色マイクロカプセルの光学特性が、内包する粒子の回転状態により変化することを特徴とする。この発明においては、着色マイクロカプセル内の粒子の回転状態を磁気的手段または電気的手段により制御することにより、着色マイクロカプセルの表面色か黒かの表示選択がなされ、容易に画像のカラー表示ないし消去が行われる。

【００２７】

【発明の実施の形態】以下、図面に基づいて本発明の実施の形態を説明する。図１は、本発明の第１の実施の形態にかかる磁気的手段による粒子回転型の表示層を示すもので、個々に所定の複数色、例えば赤（Ｒ）、緑（Ｇ）、青（Ｂ）のいずれかに着色された着色マイクロカプセル１が支持体２上に配置されて、表示層３が形成されている。着色マイクロカプセル１は、図２に示すように、着色された外殻４に白／黒のような光反射性と光吸収性の２色に色分けされた回転粒子５が流動体６とともに内包され、回転粒子５がカプセル内で自由に回転で

きるように構成されている。回転粒子５は磁性体を含有し、磁気ヘッド７等の磁気的手段により画素単位に回転制御され、光反射性の白が表側になった場合に、着色マイクロカプセル１の色が観察され、光吸収性の黒が表側になった場合には黒が観察される。

【００２８】このような表示層３において、カラー表示を行う方法として、まず色の異なる着色マイクロカプセル１をランダムに配置して、着色マイクロカプセル１の色によって回転のしきい値が異なるように設定し、印加する磁場の大きさを変えて目的の色を表示させる方法が挙げられる。着色マイクロカプセル１の回転のしきい値は、回転粒子５中の磁性体の含有量や種類、または着色マイクロカプセル１中の流動体６の粘度などの回転に影響する因子を変えることで任意に調節することができる。

【００２９】このカラー表示方法を具体例を挙げて図３を用いて説明する。図３（ａ）に示すように、支持体２上にランダムに配置されるＲ、Ｇ、Ｂの各着色マイクロカプセル１がそれぞれ５、１５、３０ガウスの回転しきい値を持つものとする。この場合、１０ガウスの磁場を加えると、Ｒの着色マイクロカプセル１のみ回転粒子５の回転制御が可能となるため、図３（ｂ）に示すように、１０ガウスの磁場で光反射率の高い方（白）の半球部分を表側に回転制御することで、Ｒを表示することができる。また、２０ガウスの磁場を加えると、Ｇの着色マイクロカプセル１の回転粒子５の回転制御が可能となるため、２０ガウスの磁場でカプセル内の回転粒子５を光反射率の高い方（白）が表側となるように回転制御することで、Ｇを表示することができる。ただし、このときＲも同時に表示されるので、Ｒの表示が必要ない場合には、続いて１０ガウスの磁場を逆方向に加えてＲの着色マイクロカプセル１の回転粒子５のみ光反射率の低い方（黒）を表側にする。同様にして、３０ガウスの磁場でＲ、Ｇ、Ｂの着色マイクロカプセル１内の回転粒子５を回転制御して光反射率の高い方（白）を表側とした後、２０ガウスの磁場でＲ、Ｇの着色マイクロカプセル１内の回転粒子５を回転制御して光反射率の低い方（黒）を表側にすることで、Ｂのみ表示することができる。

【００３０】このようにして、印加する磁場の大きさにより、目的の色を表示させることができる。このカラー表示方法では、色の異なる着色マイクロカプセル１を画素単位で配置する必要がなく、表示部と書き込み／消去を行う入力部の精密な位置合わせの必要がない。

【００３１】また、その他のカラー表示の方法として、着色マイクロカプセル１を画素単位で周期的に色が異なるように配置し、画素単位で回転粒子５の回転状態を制御する方法がある。この場合は、着色マイクロカプセル１の回転しきい値を色別に変える必要がない。

【００３２】上記いずれの方法も、着色マイクロカプセル１の色をＲ、Ｇ、Ｂの３種類にすると、Ｒ、Ｇ、Ｂ、黒はそのまま表現することができ、隣り合うＲ、Ｇ、Ｂを全て発色させれば混色により白を表現することができ、また発色させるＲ、Ｇ、Ｂの組み合わせで中間色の表現も可能になる。ただし、階調については、回転具合によるものでは難しく、画素を小さくして面積階調を行うのが現実的である。

【００３３】次に、本実施の形態の各構成要素および製造方法について説明する。着色マイクロカプセル１は、前述したように、図２に示すような構成を有し、回転粒子５が流動体６によってカプセル内で自由に回転できるようになっている。着色マイクロカプセル１の大きさは、表示装置、表示画素の大きさ（解像度）、光の散乱、製造のし易さなどとも関係するが、１～１０００μｍ程度が実用的である。

【００３４】回転粒子５は磁性体を含んでおり、２色に色分けされた一方がＮ極、他方がＳ極になるように着磁されて永久磁石となっている。回転粒子５は、磁性体の粒子、またはポリスチレン、ポリエチレン等の樹脂にマグネタイト、フェライトのような鉄、コバルト、ニッケル等の磁性体を含有させた磁性体／樹脂系粒子などが用いられる。回転粒子５の形態は、粒子の回転、停止の制御が容易で、色分け、製造の容易なものが好ましく、形状と大きさが均一なものが望まれるため、実質的には球状が好ましい。さらに、比重、化学的安定性なども重要である。特に、磁性体／樹脂系粒子は、これらを混練した後粉砕して、または磁性体粒子を分散したモノマーを乳化重合、懸濁重合または分散重合して作製することができる。

【００３５】回転粒子５を光反射性の色または光吸収性の色と着色するには、二酸化チタンなどの白色系の色素、またはカーボンなどの黒色系の色素を溶媒や必要に応じてバインダー樹脂に分散してスプレー等により塗布したり、メッキなどの電気化学的方法により被着したり、または上記色素やＡｕ、Ａｇ、Ａｌなどの金属をスパッタや蒸着などにより被着する方法等を用いることができる。また２色に塗り分けるには、非着色面を接着剤や樹脂層に埋め込んで固定したり、比重を調節した液体中に浮かべるなどの方法により、露出面にのみ着色を行う。回転粒子５が磁性体粒子の場合には、磁性体の色がほとんど黒色であることから、２色のうち一方に黒を用いる場合には、もう一方に白を着色するだけで２色に色分けすることができる。本発明のカラー表示では、マイクロカプセルの外殻に着色を施すので、白黒表示における回転粒子をそのまま使用することができる。

【００３６】着色マイクロカプセル１の外殻４を形成する材料としては、アクリル系、メタクリル系、ポリエステル、ポリスチレン、ポリウレア、ポリアミド、エポキシなど一般的な樹脂を単独または混合して使用することができる。マイクロカプセルの製造方法としては、回転

粒子５を分散させたエマルジョンの内側と外側の両方からモノマーを供給する界面重合法、回転粒子３を分散させたエマルジョンの内相あるいは外相の一方からモノマーを供給するｉｎ－ｓｉｔｕ法、あるいはその他公知のマイクロカプセル化技術を用いることができる。マイクロカプセルの外殻４は、ある程度の押圧に耐える機械的強度と、透明性および化学的安定性等の特性が求められ、必要に応じて各種樹脂などで表面を覆うなどの表面処理によって補強することもできる。また、着色マイクロカプセル１内の流動体６には、回転粒子５の回転をスムーズにするための潤滑作用が最も求められ、水、油、アルコール等の液体を用いることができる。

【００３７】これらマイクロカプセルの着色方法としては、マイクロカプセル作製後に着色する方法、または最初から目的の色を持った外殻を作製する方法などがある。前者については、Ｒ、Ｇ、Ｂなどの色素粒子を溶媒や必要に応じてバインダー樹脂に分散してスプレー等により塗布する方法、メッキなどの電気化学的方法やスパッタ、蒸着などにより被着する方法等が挙げられるが、回転粒子５の場合よりも２色に塗り分ける必要がないので容易である。後者については、外殻を重合する際に目的の色の色素を混入しておき、色素を含んだ色の付いた外殻を重合生成する方法などが挙げられる。なお、三原色の分光特性を有する色素としては、ペリレン顔料、レーキ顔料、アゾ系顔料、キナクリドン系顔料、アントラキノン系顔料、金属置換フタロシアニン系顔料、ハロゲン多置換フタロシアニン系顔料などの有機顔料、酸化チタン、酸化鉄、コバルト紫、コバルトブルーなどの無機顔料が挙げられる。

【００３８】このようにして作製した着色マイクロカプセル１をランダムに、または画素単位で周期的に色が異なるように支持体２上に配置して表示層３を形成する。ランダムに配置する場合には、アクリル系、メタクリル系、ポリエステル、ポリスチレン、ポリウレア、ポリアミド、エポキシなど一般的な樹脂溶液に各色の着色マイクロカプセル１を混合分散して支持体２上に塗布乾燥したり、支持体２上に接着層を設けて、溶媒に分散した各色の着色マイクロカプセル１をキャストする方法で表示層３を形成することができる。もちろんこの形成方法については限定されるものではない。表示層３の厚さは、その上に保護層や支持体基板等を設けることを前提とすれば、着色マイクロカプセル１の粒径と同程度でも十分である。

【００３９】一方、着色マイクロカプセル１を画素単位で周期的に色が異なるように配置して表示層３を形成する場合には、着色マイクロカプセル１を分散したフォトレジストを用いたフォトリソグラフィー法を用いることができる。この方法は、図４に示すように、例えばＲの着色マイクロカプセル１を分散させたフォトレジスト１１を塗布、乾燥、露光、現像の一連のフォトリソプロセスにより、所定の画素に配置し固定する。続いて、同様のフォトリソプロセスにより、Ｇの着色マイクロカプセル１、Ｂの着色マイクロカプセル１を順次所定の画素に配置し固定する。この場合、表示層３として残るフォトレジスト層は着色マイクロカプセル１を固定する程度で十分であるため、その厚さは着色マイクロカプセル１の粒径と同程度かそれ以下が好ましい。これは、フォトリソのプロセス条件を制御することで可能となる。また、フォトレジストとしては、例えばアクリレート樹脂にベンゾフェノン類、アントラキノン類などの光重合開始剤を含有したネガ型レジスト、またはノボラック型フェノール樹脂にｏ－キノンジアジドのエステル化物を含有したポジ型レジストなどを用いることができるが、これに限定されることはなく、透明性で着色マイクロカプセル１の分散性および表示層３を形成したときの接着性等が優れたものであればよい。

【００４０】その他の着色マイクロカプセル１を画素単位で周期的に配置する方法としては、電気化学的方法などがあり、具体的には電着法、ミセル電解法などが挙げられる。電気化学的方法の場合、いずれも表示層３を形成する部分に電極となる導電層が必要となる。したがって、各画素間では、導通しないような電極構成が必要となるが、着色マイクロカプセル１のパターニング配置の工程は容易である。また、回転粒子の回転制御を電気的手段により行う場合には、表示層を形成するための電極がそのまま表示駆動用の電極として利用することができる。

【００４１】図５は、図１に示す表示層３を用いた表示シートの一実施の形態を示すもので、支持体２上に形成された表示層３の上側に保護層２１が設けられ、表示情報を保持するためのメモリー層２２が支持体２の下側に形成されている。支持体２は、ポリエチレンテレフタレート、ポリカーボネート、ポリエチレンなどの樹脂フィルムや樹脂プレートを用いることができるが、特に限定されるものではない。その厚さは、書込み／消去を行うことを考慮すると薄い方が好ましいが、シートとしての扱い易さを考慮するとある程度の厚みが必要で、１０～１０００μｍ程度が好ましい。

【００４２】保護層２１は、磁気ヘッド、さらに実使用における様々な押圧、摩擦に対して耐久性があり、透明性が高く、安定なものが用いられ、樹脂を塗布したり、樹脂フィルムや樹脂プレートを張り合わせたりすることによって形成される。その厚さは、視認性の観点からは薄い方が好ましいが、上部から書込み／消去を行う場合、その機械的強度との兼ね合いで１０～１０００μｍ程度が好ましい。

【００４３】メモリー層２２は主に半硬質磁性材料からなり、磁気的手段によって書き込んだ表示情報を、書込みの磁界を切っても、また使用環境にある程度の磁場が存在しても、メモリー層２２の磁化によって保持するこ

とができる。メモリー層２２の厚さは、用いる磁性材料および作製方法にもよるが、０．１～１０μｍ程度が好ましい。メモリー層２２がない場合には、必要に応じて表示情報を保持するために、例えば粒子回転のしきい値を設定するなどの方法が考えられる。

【００４４】表示シートの場合、書込み／消去する入力部とは切り離して、表示部分のみ独立させることが可能である。したがって、各種構成材料をプラスチックフィルムなどのフレキシブルな材料を用いることにより、軽く紙のように取扱い可能な表示手段となる。

【００４５】上記表示シートに画像情報を入力または消去する手段としては、例えば、表示層３下部から１次元または２次元の磁気ヘッドアレイが用いられる。また、一部分の追記／消去には、表示層３の上部から磁気ペンなどの使用が可能となる。なお、１次元の磁気ヘッドアレイを用いる場合には、主走査方向に移動する手段を用いて表示領域全体の画像を記録する。表示シートがこのような書込み／消去手段と切り離されている場合には、これらと位置合わせして接続し、書込み／消去を行うことになる。

【００４６】図６は、図１に示す表示層３を用いた表示装置の一実施の形態を示すもので、表示層３、保護層２１および必要に応じてメモリー層２２からなる表示部と、磁気ヘッド層２３などの書込み／消去を行う入力部が一体となって支持体２上に形成されている。前述の表示シートは入力部から切り離して紙のような表示媒体として扱うことができたが、この表示装置は、設置場所を固定したディスプレイとして使用することになる。この場合には、表示シートと異なって表示部を入力部から切り離すことがないため、表示部と書込み／消去を行う入力部との位置合わせを行う必要がなく、カラー表示には特に有利となる。

【００４７】次に、本発明の第２の実施の形態にかかる電気的手段による粒子回転型の表示層を図７に示す。この実施の形態は、第１の実施の形態と同様に、所定の複数色、例えば赤（Ｒ）、緑（Ｇ）、青（Ｂ）のいずれかに着色された着色マイクロカプセル３１が支持体２上に配置されて、表示層３３が形成されている。着色マイクロカプセル３１は、第１の実施の形態とは異なって、電気的手段によって回転可能な回転粒子３５を内包している。このため、本実施の形態では、回転粒子３５は光反射性と光吸収性の２色に色分けられた部分が異なる帯電特性を有するよう構成されており、電気的手段として、画素単位に電界印加が可能なように表示層３３を挟んで上部電極３６、下部電極３７が配置されている。

【００４８】本実施の形態においても、色の異なる着色マイクロカプセル３１をランダムに配置して、着色マイクロカプセル３１の色によって回転のしきい値が異なるように設定し、印加する電界の大きさを変えて目的の色を表示させる方法、および着色マイクロカプセル３１を画素単位で周期的に色を替えて配置し、画素単位で回転粒子３５の回転状態を制御して目的の色を表示させる方法等をとることができる。着色マイクロカプセル３１を支持体２上に配置し固定する方法は第１の実施の形態の場合と同様である。

【００４９】上記構成において、第１の実施の形態と異なる部分について説明する。第１の実施の形態の回転粒子５が２つの磁極を持った粒子であるのに対して、本実施の形態の回転粒子３５は異なる帯電特性を有する粒子である。これは粒子表面を半球ずつ異なる物質で覆うことによって作製される。つまり、２色に色分けする際に、通常、表面を色の異なる物質で覆うことになるが、それがそのまま異なる帯電特性を与えることになる。ただし、実際にはそれが粒子回転に寄与できるとは限らないため、帯電特性の大きく異なるような材料が添加される。これには帯電制御の容易さから、ワックス状物質がよく用いられるが、例えば、ステアリン酸やパルミチン酸やラウリン酸などの高級脂肪酸類、ステアリン酸アルミニウムなどの高級脂肪酸金属塩類、高級脂肪酸誘導体、カルナバワックスやパラフィンワックスなどのワックス類、ポリエチレン、ポリプロピレン、エチレン－酢酸ビニル共重合体等が挙げられる。また、回転粒子３５は、回転粒子５と同様に図２に示すようなマイクロカプセル内に内包して用いることができるが、マイクロカプセル内の流動体６には、透明なシリコンオイルなどの誘電体が用いられる。

【００５０】また、電気的手段により回転粒子を制御するカラー表示方式では、図７に示すように、表示層３３の上下に画素単位にパターニングされた上部電極３６、下部電極３７が必要となる。このうち、上部の電極３６は透明電極であることが必要である。この透明電極としては、In_2O_3、SnO_2、ＺｎＯ、ＣｄＯ、TiO_2、In_2O_3－Ｓｎ、SnO_2－Ｓｂ等の酸化物半導体薄膜など公知のものが用いられる。

【００５１】一方、下部電極３７は透明電極である必要ではなく、むしろ光反射率の高い材料を用いると、表示層３３の上面から見た場合、回転粒子３５の間に入射した光が反射して戻ってくるため、表示層３３の明るさ向上させることができる。下部電極３７としては、透明電極のほかに、Ａｕ、Ａｇ、Ｃｕ、Ｐｔ、Ａｌなどが挙げられる。

【００５２】図８は、図７に示す表示層３３を用いた表示シートの一実施の形態を示すもので、図５に示す表示シートと同様に、支持体２上に形成された表示層３３の上側に保護層２１が設けられている。この場合、表示情報の保持は、必要に応じて粒子回転のしきい値を設定するなどの方法により達成される。この表示シートの支持体５および保護層２１として好適な材料は、図５に示す表示シートの場合と同様に選択される。なお、この他の実施の形態として、表示層３３の上部の電極、および／

または下部の電極をシート部内に組み込む形態も考えられる。

【００５３】図９は、図７に示す表示層３３を用いた表示装置の一実施の形態を示すもので、表示層３３からなる表示部と、この表示層３３に各画素単位に電界印加が可能に配置された上部電極３６、３７からなる入力部が一体となって支持体２上に形成され、表示層３３および上部電極３６の上面に保護層２１が形成されている。このように、表示部と書込み／消去を行う入力部が一体となっているため、表示シートのように表示部と入力部との位置合わせを行う必要がなく、カラー表示には特に有利である。

【００５４】なお、上記実施の形態では、粒子回転型を例に挙げて説明したが、本発明はこれに限定されることなく、マイクロカプセルを用いた電気泳動型、磁気泳動型、分散粒子配向型においても適用することができる。

【００５５】

【実施例】以下、本発明の実施例を説明する。なお、実施例１は第１の実施の形態に、実施例２は第２の実施の形態に対応する。

【００５６】実施例１

磁性体としてγ－Fe_2O_3微粒子を含有したポリスチレン球状粒子、磁性体としてFe_3O_4微粒子を含有したポリスチレン球状粒子、磁性体としてFe_4N微粒子を含有したポリスチレン球状粒子をそれぞれ公知の懸濁重合法にて作製した。なお、粒径はいずれも約８μｍとなるようにした。これらを耐熱性アクリル接着層をつけたガラス基板上に粒子の下部が埋没するように接着し、半球上部を白に着色液（酸化チタン／ポリビニルブチラール／メチルエチルケトン）でスプレー塗布し、続いて１ＫＧの電磁石で着磁を行い、接着層から剥がし、白／黒２色に色分けされ、着磁された粒子を３種類作製した。

【００５７】次に、公知のゼラチンとアラビアゴムのコアセルベーション法にて回転粒子とシリコンオイルを内包したマイクロカプセルを作製した。このようにして作製したマイクロカプセルを、内包した回転粒子の種類に応じて、それぞれＲの着色液（ペリレンレッド／ポリビニルアルコール／水）、Ｇの着色液（フタロシアニングリーン／ポリビニルアルコール／水）、Ｂの着色液（フタロシアニンブルー／ポリビニルアルコール／水）に浸漬塗布し乾燥して、Ｒに着色したマイクロカプセル、Ｇに着色したマイクロカプセル、Ｂに着色したマイクロカプセルを得た。

【００５８】次に、ポリビニルブチラール／メチルエチルケトン溶液中にＲ、Ｇ、Ｂの３種類の着色マイクロカプセルを同量ずつ加えて十分に混合した後、１００μｍのポリカーボネートフィルム上にブレード塗布し乾燥して、Ｒ、Ｇ、Ｂの着色マイクロカプセルをランダムに配置した表示層を作製した。この表示層の上に熱硬化型のアクリル樹脂を塗布した後、１５０℃２０分ベークして１００μｍの保護層を形成し、カラー表示用シートを作製した。この表示用シートにおいて、Ｒの着色マイクロカプセル内の粒子回転のしきい値は約５ガウス、Ｇの着色マイクロカプセル内の粒子回転のしきい値は約１５ガウス、Ｂの着色マイクロカプセル内の粒子回転のしきい値は約３０ガウスであった。この表示用シートを２次元磁気ヘッドアレイに密着して書き込み／消去を行ったところ、混色によるカラー表示が可能であった。

【００５９】実施例２

サンワックスＥ－２００（三洋化成工業製）とカーボンブラックを混練し、スプレードライヤー法にて造粒し、分級して約１５μｍの黒色粒子を作製した。これを実施例１と同様の方法にて、半球部に白色を着色して白／黒２色に色分けされた回転粒子を作製した後、マイクロカプセル化し、Ｒ、Ｇ、Ｂの３種類に着色した。なお、今回は、実施例１とは異なって、どの色の着色マイクロカプセルも内包した回転粒子は同じである。

【００６０】次に、光硬化型透明感光性樹脂のモノマー溶液（東京応化工業ＯＭＲ－８３）にＲの着色マイクロカプセルを分散し、スピンコート法にて１００μｍのポリカーボネートフィルム上に塗布し、９０℃のオーブンで５分間プリベークを行った。これをフォトマスクを介して超高圧水銀灯で全面露光（４００ｍＪ／ｃｍ²）し、０．２％炭酸水素ナトリウム水溶液で２５℃で６０秒間現像処理後、１５０℃３０分のポストベークを行ってＲの着色マイクロカプセルを所定の位置にパターニング配置した。続いて、同様にしてＧの着色マイクロカプセルを配置し、最後にＢの着色マイクロカプセルを配置して、１００×１００μｍの画素に周期的にＲ、Ｇ、Ｂの３種類の着色マイクロカプセルが配置された約１５μｍ厚の表示層を形成した。

【００６１】このようにして作製した表示層上に、熱硬化型のアクリル樹脂を塗布した後、１５０℃２０分ベークして１００μｍの保護層を形成し、カラー表示用シートを作製した。この表示用シートに表示層上下に配置した電極にて電界を加えて書き込み／消去を行ったところ、混色によるカラー表示が可能であった。

【００６２】

【発明の効果】上記したように、請求項１～７の発明によれば、受光型のため目の疲れが少なく、ＬＣＤよりも広視野角のカラー表示が比較的簡単な構成で低コストで実現することができる。

【００６３】また、請求項３、１０、１４の発明によれば、表示層の製造プロセスの大幅な簡素化を実現することができる。

【００６４】また、請求項４、１１、１５の発明によれば、カラー表示のための制御性を容易にすることができる。

【００６５】また、請求項８～１２の発明によれば、簡

単な構成で広視野角のカラー表示シートを得ることができ、低コストで紙のように薄くてフレキシブルなカラー表示シートを作製することができる。

【００６６】また、請求項１３～１６の発明によれば、目の疲れが少なく、ＬＣＤよりも広視野角のカラー表示装置を比較的簡単な構成で低コストで実現することができる。

【図面の簡単な説明】

【図１】本発明の第１の実施の形態にかかる磁気的手段による粒子回転型の表示層を示す断面図である。

【図２】マイクロカプセルの構成を示す図である。

【図３】しきい値磁場によるカラー表示例を示す図である。

【図４】フォトリソグラフィー法による着色マイクロカプセルの配置工程例を示す図である。

【図５】図１に示す表示層を用いた表示シートの一実施の形態を示す断面図である。

【図６】図１に示す表示層を用いた表示装置の一実施の形態を示す断面図である。

【図７】本発明の第２の実施の形態にかかる電気的手段による粒子回転型の表示層を示す断面図である。

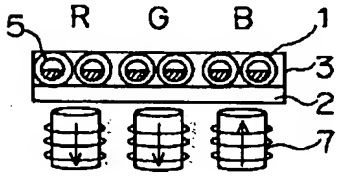
【図８】図７に示す表示層を用いた表示シートの一実施の形態を示す断面図である。

【図９】図７に示す表示層を用いた表示装置の一実施の形態を示す断面図である。

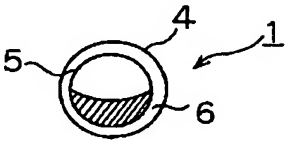
【符号の説明】

１、３１……着色マイクロカプセル
２……支持体
３、３３……表示層
４……外殻
５、３５……回転粒子
６……流動体
７……磁気ヘッド
２１……保護層
２２……メモリー層
２３……磁気ヘッド層
３６……上部電極
３７……下部電極

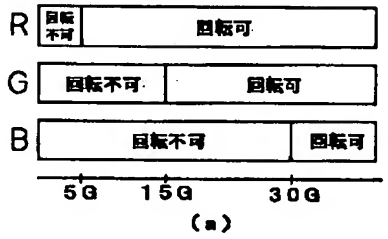
【図１】



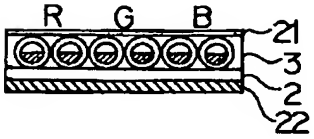
【図２】

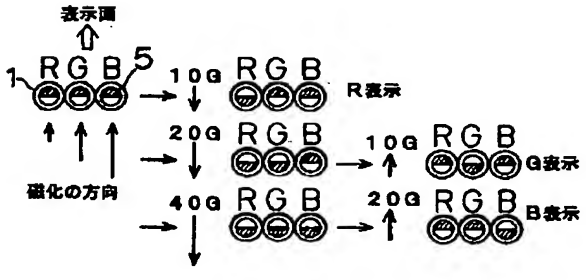


【図３】

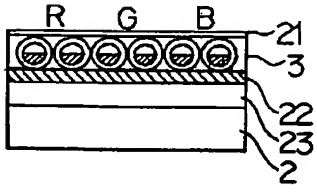


【図５】

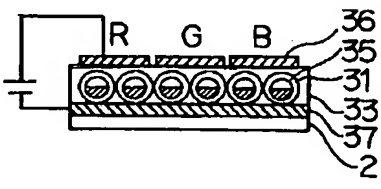




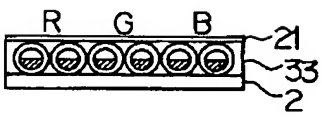
【図６】



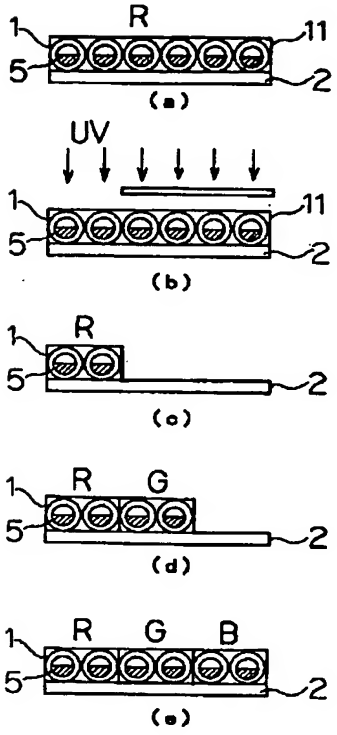
【図７】



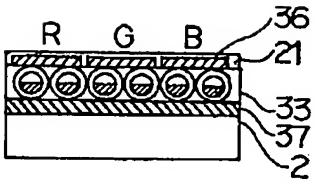
【図８】



【図４】



【図９】



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CLAIMS

[Claim(s)]
[Claim 1] The color display approach characterized by carrying out color display of the image by arranging two or more kinds of coloring microcapsules with which the surface color differs, controlling the condition of the particle by which endocyst was carried out to each coloring microcapsule, and changing the optical property of a coloring microcapsule.
[Claim 2] The color display approach characterized by the surface color of said coloring microcapsule being three kinds, red, green, and blue, in the color display approach according to claim 1.
[Claim 3] The color display approach characterized by setting up the control threshold to which the optical property of said coloring microcapsule is changed in the color display approach according to claim 1 so that it may differ according to the class, arranging two or more kinds of coloring microcapsules at random, changing the optical property of the coloring microcapsule of the target class alternatively, and carrying out color display of the image.
[Claim 4] The color display approach characterized by said thing [arranging two or more coloring microcapsules of a class so that classes may differ periodically per pixel, changing the optical property of a coloring microcapsule per pixel and carrying out color display of the image] in the color display approach according to claim 1.
[Claim 5] The color display approach characterized by for said coloring microcapsule connoting the particle classified by two colors of light reflex nature and light absorption nature by color pivotable in the color display approach according to claim 1, and changing the optical property of a coloring microcapsule according to the rotation condition of this particle.
[Claim 6] The color display approach characterized by said coloring microcapsule connoting a pivotable particle according to a magnetic operation in the color display approach according to claim 5.
[Claim 7] The color display approach characterized by said coloring microcapsule connoting a pivotable particle by the electric action in the color display approach according to claim 5.
[Claim 8] The display sheet characterized by having the display layer in which two or more kinds of coloring microcapsules with which the surface color from which an optical property changes with the conditions of the particle to connote differs were arranged.
[Claim 9] The display sheet characterized by the surface color of said coloring microcapsule being three kinds, red, green, and blue, in a display sheet according to claim 8.
[Claim 10] The display sheet characterized by for the control thresholds to which the optical property of said coloring microcapsule is changed differing in a display sheet according to claim 8 according to a class, and arranging two or more kinds of coloring microcapsules at random.
[Claim 11] The display sheet with which the coloring microcapsule of a class is characterized by two or more said things [changing a class periodically per pixel and being arranged] in a display sheet according to claim 8.
[Claim 12] The display sheet to which said coloring microcapsule connotes the particle classified by two colors of light reflex nature and light absorption nature by color pivotable in a display sheet according to claim 8, and the rotation condition of this particle is characterized by the controllable thing with a magnetic means or an electric means.

[Claim 13] The display characterized by having the display layer in which two or more kinds of coloring microcapsules with which the surface color from which an optical property changes with the conditions of the particle to connote differs were arranged, and an input means to control the particle condition in a coloring microcapsule per pixel of said display layer, and to perform the writing or elimination of an image.
[Claim 14] The display characterized by for the control thresholds to which the optical property of said coloring microcapsule is changed differing in a display according to claim 13 according to a class, and arranging two or more kinds of coloring microcapsules at random.
[Claim 15] The display with which the coloring microcapsule of a class is characterized by two or more said things [changing a class periodically per pixel and being arranged] in a display according to claim 13.
[Claim 16] The display characterized by the optical property of said coloring microcapsule changing with the rotation conditions of the particle to connote in a display according to claim 13.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the display technique which carries out color display of the images, such as a graphic form and an alphabetic character.
[0002]
[Description of the Prior Art] As a display which displays information, although current [the viewpoint of the display quality and economical efficiency to] is in use as for CRT, various flat-panel displays are done [research and development in them] and put in practical use in consideration of small, the light weight, the low power, etc. As such a display, light-receiving mold displays, such as luminescence mold displays, such as a plasma display (PDP), an electroluminescence display (ELD), a fluorescent indicator tube (VFD), and a light emitting diode (LED), and a liquid crystal display (LCD), are mentioned.
[0003] Although the eye by flicker etc. is expected little display of fatigue since these get used and have so far been familiar with a medium called printed matter in OA field mainly applied, it is difficult to solve this point on luminescence mold displays including CRT. In that respect, although LCD of a light-receiving mold is advantageous and there are also advantages, such as a low power, the actual condition is that there are also characteristic demerits, such as an angle-of-visibility dependency and temperature dependence.
[0004] Then, it had the image display layer which a light-receiving mold display also becomes from a microcapsule, and magnetic or the method which performs image display, for example, an electrophoresis display, the magnetic migration display, the particulate material orientation mold display, the rotation particle mold display using electric or a magnetic means, etc. have been proposed by changing the rate of a light reflex per pixel by the electric action. With the microcapsule which connotes the liquid which distributed the particle of light absorption nature or light reflex nature, an electrophoresis display forms an image display layer and sets it to a microcapsule here. If an electric double layer is formed of transfer of the charge in a solid-liquid interface, a particle is charged in forward or negative and electric field are added to this, an image will be displayed using a particle migrating according to the direction of electric field by attaching the contrast of the light and darkness of the display layer upper part for every pixel.
[0005] Moreover, if a magnetic migration display forms an image display layer and a field is added with the microcapsule which connotes the liquid which distributed the magnetic-substance particle of light absorption nature, and the non-magnetic-material particle of light reflex nature, it will display an image using a magnetic-substance particle being attracted in a microcapsule by attaching the contrast of the light and darkness of the display layer upper part for every pixel.
[0006] Moreover, if a particulate material orientation mold display forms an image display layer and a field is added with the microcapsule which connotes the dispersion liquid of a magnetic-substance particle with shape anisotropy, such as flat nature, it will display an image using reflection of the light according to the sense of a magnetic-substance particle with shape anisotropy, dispersion, and absorption taking place by attaching the contrast of the light and darkness of the display layer upper part for every pixel.
[0007] Furthermore, a rotation particle mold display forms an image display layer with the

microcapsule which connotes with a fluid the spherical rotation particle classified by every [a semi-sphere] by color, and is magnetic or a thing which displays an image by carrying out the roll control of the spherical rotation particle in a microcapsule, and attaching the contrast of the light and darkness of the display layer upper part for every pixel with an electric means etc.
[0008]
[Problem(s) to be Solved by the Invention] However, in the present condition, these displays are only monochrome monochromatic specification and had the problem that color display was not put in practical use compared with CRT or LCD. For this reason, although what arranges the color filter of two or more colors, and performs color display on a display layer is proposed (JP,10-232630,A), since lamination becomes complicated, this influences display properties, such as brightness and contrast, a production process not only increases, but and its thickness increases also in the case of the writing/elimination from the display layer upper part when a color filter layer is added, it becomes disadvantageous while it can consider the cost rise by using a color filter.
[0009] This invention coped with the trouble of the above-mentioned conventional technique, was made, and it aims at magnetic or offering a display in the color display approach that color display can be performed, and the display sheet list using this color display approach, by easy control using the image display approach of changing the rate of a light reflex per pixel by the electric action, without complicating a configuration.
[0010]
[Means for Solving the Problem] That is, the color display approach of invention of claim 1 is characterized by carrying out color display of the image by arranging two or more kinds of coloring microcapsules with which the surface color differs, controlling the condition of the particle by which endocyst was carried out to each coloring microcapsule, and changing the optical property of a coloring microcapsule.
[0011] In the color display approach of this invention, it is changing with the conditions of the particle which the rate of a light reflex of a coloring microcapsule connotes, and the surface color of a coloring microcapsule is displayed, or it becomes possible to make it display black, and the color display of an image becomes possible. Thereby, implementation of the color display of a wide-field-of-view angle is attained few from LCD by the fatigue of an eye by low cost with a comparatively easy configuration for a light-receiving mold.
[0012] Invention of claim 2 is characterized by the surface color of a coloring microcapsule being three kinds, red, green, and blue, in the color display approach of claim 1. Thereby, full color image display becomes possible in the combination of red, green, blue, and black.
[0013] In the color display approach of claim 1, invention of claim 3 sets up the control threshold to which the optical property of a coloring microcapsule is changed so that it may differ according to the class, it arranges two or more kinds of coloring microcapsules at random, changes the optical property of the coloring microcapsule of the target class alternatively, and is characterized by carrying out color display of the image. In this invention, the array of the coloring microcapsule with which colors differ is easy, without requiring the precise alignment of a display and the input section which performs writing/elimination, it is changing in the size of the magnetic operation impressed to a coloring microcapsule, or an electric action, and color display becomes possible.
[0014] In the color display approach of claim 1, invention of claim 4 arranges two or more kinds of coloring microcapsules so that classes may differ periodically per pixel, it changes the optical property of a coloring microcapsule per pixel, and is characterized by carrying out color display of the image. It is not necessary to change the control threshold to which the optical property of a coloring microcapsule is changed according to that class, and color display becomes possible easily by control of a pixel unit in this invention.
[0015] In the color display approach of claim 1, a coloring microcapsule connotes the particle classified by two colors of light reflex nature and light absorption nature by color pivotable, and invention of claim 5 is characterized by changing the optical property of a coloring microcapsule according to the rotation condition of this particle. When the surface color of the coloring microcapsule which connoted this rotation particle by this when the field of the light reflex

nature of a rotation particle was turned to a side front is displayed and the field of light absorption nature is turned to a side front, black is displayed and the color display of an image becomes possible.

[0016] Invention of claim 6 is characterized by a coloring microcapsule connoting a pivotable particle according to a magnetic operation in the color display approach of claim 5. This becomes possible to control the rotation condition of a particle by magnetic means, such as the magnetic head, and color display which excelled [configuration / easy] in visibility is realized.

[0017] Invention of claim 7 is characterized by a coloring microcapsule connoting a pivotable particle by the electric action in the color display approach of claim 5. Thereby, the rotation condition of the particle in a coloring microcapsule can be easily controlled using the electric-field impression drive method by the pixel electrode, and color display of high resolution is realized.

[0018] The display sheet of invention of claim 8 is characterized by having the display layer in which two or more kinds of coloring microcapsules with which the surface color from which an optical property changes with the conditions of the particle to connote differs were arranged. In this invention, it becomes possible by controlling the condition of the particle in a coloring microcapsule and changing the optical property of the target coloring microcapsule to display an image in a color easily. Moreover, since the configuration is easy as a display sheet, the color display sheet of a thin and flexible wide-field-of-view angle is obtained like paper, and it becomes producible by low cost.

[0019] Invention of claim 9 is characterized by the surface color of a coloring microcapsule being three kinds, red, green, and blue, in the display sheet of claim 8. Thereby, full color image display becomes possible in the combination of red, green, blue, and black.

[0020] In the display sheet of claim 8, the control thresholds to which the optical property of a coloring microcapsule is changed differ according to a class, and invention of claim 10 is characterized by arranging two or more kinds of coloring microcapsules at random. without requiring the precise alignment of a display sheet and an input means to perform writing/elimination, while the array of the coloring microcapsule with which colors differ is easy and comes out in this invention, it is changing in the size of the magnetic operation impressed to a coloring microcapsule, or an electric action, and color display becomes possible.

[0021] Invention of claim 11 is characterized by for two or more kinds of coloring microcapsules changing a class periodically per pixel, and arranging them in the display sheet of claim 8. It is not necessary to change the control threshold to which the optical property of a coloring microcapsule is changed according to that class, and color display becomes possible easily by control of a pixel unit in this invention.

[0022] Invention of claim 12 connotes the particle by which the coloring microcapsule was classified by two colors of light reflex nature and light absorption nature by color pivotable in the display sheet of claim 8, and the rotation condition of this particle is characterized by the controllable thing with a magnetic means or an electric means. In this invention with magnetic means, such as the magnetic head, or the electric means of a pixel electrode etc. When the rotation condition of the particle in the coloring microcapsule of a display sheet can be controlled and the field of the light reflex nature of a rotation particle is turned to a side front When the surface color of the coloring microcapsule which connoted this rotation particle is displayed and the field of light absorption nature is turned to a side front, black is displayed and the color display of an image becomes possible.

[0023] The display of invention of claim 13 is characterized by having the display layer in which two or more kinds of coloring microcapsules with which the surface color from which an optical property changes with the conditions of the particle to connote differs were arranged, and an input means to control the particle condition in a coloring microcapsule per pixel of a display layer, and to perform the writing or elimination of an image. In this invention, it is that an input means controls the particle condition in the coloring microcapsule of a display layer per pixel, and display selection of the surface color of a coloring microcapsule or black is made, and color display of an image thru/or elimination are performed easily.

[0024] In the display of claim 13, the control thresholds to which the optical property of a

coloring microcapsule is changed differ according to a class, and invention of claim 14 is characterized by arranging two or more kinds of coloring microcapsules at random. In this invention, the array of the coloring microcapsule with which colors differ is easy, and is changing in the size of the magnetic operation impressed to a coloring microcapsule, or an electric action, and the color display of it becomes possible.

[0025] Invention of claim 15 is characterized by for two or more kinds of coloring microcapsules changing a class periodically per pixel, and arranging them in the display of claim 13. It is not necessary to change the control threshold to which the optical property of a coloring microcapsule is changed according to that class, and color display becomes possible easily by control of a pixel unit in this invention.

[0026] Invention of claim 16 is characterized by the optical property of a coloring microcapsule changing with the rotation conditions of the particle to connote in the display of claim 13. In this invention, by controlling the rotation condition of the particle in a coloring microcapsule by the magnetic means or the electric means, display selection of the surface color of a coloring microcapsule or black is made, and color display of an image thru/or elimination are performed easily.

[0027]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. Drawing 1 shows the display layer of the particle rotation mold by the magnetic means concerning the gestalt of operation of the 1st of this invention, the coloring microcapsule 1 colored separately at predetermined two or more colors (R), for example, red, green (G), or blue (B) is arranged on a base material 2, and the display layer 3 is formed. As shown in drawing 2 , the endocyst of the rotation particle 5 classified by two colors of light reflex nature like white/black and light absorption nature by color is carried out to the colored outer shell 4 with a fluid 6, and the coloring microcapsule 1 is constituted so that the rotation particle 5 can rotate freely within a capsule. When the rotation particle 5 contains the magnetic substance, a roll control is carried out by the magnetic means of magnetic-head 7 grade per pixel and the white of light reflex nature becomes a side front, the color of the coloring microcapsule 1 is observed, and black is observed when the black of light absorption nature becomes a side front.

[0028] The method of arranging at random the coloring microcapsule 1 with which colors differ first, setting up so that a rotational threshold may change with colors of the coloring microcapsule 1, changing the magnitude of the magnetic field to impress, and displaying the target color is mentioned as an approach of performing color display in such a display layer 3. The threshold of rotation of the coloring microcapsule 1 can be adjusted to arbitration by changing the factor which influences rotation of the content of the magnetic substance in the rotation particle 5, the viscosity of the fluid 6 in a class or the coloring microcapsule 1, etc.

[0029] An example is given and this color display approach is explained using drawing 3 . As shown in drawing 3 (a), each coloring microcapsule 1 of R, G, and B which are arranged at random shall have 5 and the rotation threshold which is 15 or 30 gauss on a base material 2, respectively. In this case, if a 10 gauss magnetic field is added, since the roll control of the rotation particle 5 only of the coloring microcapsule 1 of R will become possible, as shown in drawing 3 (b), R can be displayed by carrying out the roll control of the semi-sphere part with the higher rate of a light reflex (white) to a side front in a 10 gauss magnetic field. Moreover, if a 20 gauss magnetic field is added, since the roll control of the rotation particle 5 of the coloring microcapsule 1 of G will become possible, G can be displayed by carrying out the roll control of the rotation particle 5 in a capsule in a 20 gauss magnetic field so that the one (white) where the rate of a light reflex is higher may serve as a side front. However, since R is also displayed on coincidence at this time, when the display of R is unnecessary, a 10 gauss magnetic field is continuously added to hard flow, and only the rotation particle 5 of the coloring microcapsule 1 of R makes a side front the one (black) where the rate of a light reflex is lower. After similarly carrying out the roll control of the rotation particle 5 in the coloring microcapsule 1 of R, G, and B in a 30 gauss magnetic field and making into a side front the one (white) where the rate of a light reflex is higher, only B can be displayed by carrying out the roll control of the rotation

particle 5 in the coloring microcapsule 1 of R and G in a 20 gauss magnetic field, and making into a side front the one (black) where the rate of a light reflex is lower.
[0030] Thus, the target color can be displayed with the magnitude of the magnetic field to impress. It is not necessary to arrange the coloring microcapsule 1 with which colors differ per pixel by this color display approach, and there is no need for the precise alignment of a display and the input section which performs writing/elimination.
[0031] Moreover, as the approach of other color displays, the coloring microcapsule 1 is arranged so that colors may differ periodically per pixel, and there is the approach of controlling the rotation condition of the rotation particle 5 per pixel. In this case, it is not necessary to change the rotation threshold of the coloring microcapsule 1 according to a color.
[0032] the above -- if any approach makes the color of the coloring microcapsule 1 three kinds, R, G, and B, the expression of neutral colors will also be attained in the combination of R, G, and B which can express R, G, B, and black as it is, can express white with color mixture if all of R, adjacent G, and adjacent B are made to color, and are made to color. However, about gradation, it is difficult and it is realistic to make a pixel small and to perform area gradation what is depended on rotation condition.
[0033] Next, each component and the manufacture approach of a gestalt of this operation are explained. As mentioned above, the coloring microcapsule 1 has a configuration as shown in drawing 2 , and the rotation particle 5 can rotate it now freely within a capsule with a fluid 6. Although the magnitude of the coloring microcapsule 1 is related to the ease of carrying out of the magnitude (resolution) of a display and a display pixel, dispersion of light, and manufacture etc., its about 1-1000 micrometers are practical.
[0034] The rotation particle 5 contains the magnetic substance, it is magnetized so that it might be classified by two colors by color, while N pole and another side may become the south pole in them, and it serves as a permanent magnet. The magnetic substance / resin system particle to which the rotation particle 5 made resin, such as a particle of the magnetic substance or polystyrene, and polyethylene, contain the magnetic substance, such as magnetite, iron like a ferrite, cobalt, and nickel, are used. Rotation of a particle and control of a halt are easy for the gestalt of the rotation particle 5, and it is desirable, and since what has a uniform configuration and magnitude is desired, it is substantially desirable. [of the shape of a ball] [of the easy thing of classification by color and manufacture] Furthermore, specific gravity, chemical stability, etc. are important. the monomer which ground it after especially the magnetic substance / resin system particle kneaded these, or distributed the magnetic-substance particle -- an emulsion polymerization and a suspension polymerization -- or a distributed polymerization can be carried out and it can produce.
[0035] In order to color the rotation particle 5 with the color of light reflex nature, or the color of light absorption nature, it can apply with a spray etc., or can cover with electrochemical processes, such as plating, or the approach of distributing the coloring matter of black systems, such as coloring matter of white systems, such as a titanium dioxide, or carbon, to binder resin a solvent and if needed, and putting metals, such as the above-mentioned coloring matter, and Au, Ag, aluminum, by the spatter, vacuum evaporationo, etc. can be used. Moreover, in order to distinguish by different color with in two colors, embed a non-coloring field in adhesives or a resin layer, and it fixes, or is colored only an exposure by floating into the liquid which adjusted specific gravity etc. Since the color of the magnetic substance is almost black when the rotation particle 5 is a magnetic-substance particle, when using black for one side between two colors, it can classify by color in two colors only by coloring white another side. In the color display of this invention, since it is colored the outer shell of a microcapsule, the rotation particle in monochrome display can be used as it is.
[0036] independent [in common resin, such as acrylic, an methacrylic system, polyester, polystyrene, poly urea, a polyamide, and epoxy,] as an ingredient which forms the outer shell 4 of the coloring microcapsule 1 -- or it can be mixed and used. As the manufacture approach of a microcapsule, the in-situ method which supplies a monomer from one side of the internal phase of an emulsion or external phase who distributed the interfacial polymerization which supplies a monomer, and the rotation particle 3, or a microencapsulation technique well-known in addition

to this can be used from both the inside of an emulsion which distributed the rotation particle 5, and an outside. Properties, such as a mechanical strength which is equal to a certain amount of press, and transparency, chemical stability, are searched for, and the outer shell 4 of a microcapsule can also be reinforced by surface treatment, such as covering a front face by various resin etc. if needed. Moreover, the fluid 6 in the coloring microcapsule 1 is most asked for the lubrication action for making rotation of the rotation particle 5 smooth, and it can use liquids, such as water, an oil, and alcohol, for it.

[0037] As the coloring approach of these microcapsules, there is an approach of coloring after microcapsule production or the approach of producing the outer shell which had the target color from the beginning. Although the approach of putting by electrochemical processes which distribute coloring matter particles, such as R, G, and B, to binder resin a solvent and if needed, and are applied with a spray etc. about the former, such as an approach and plating, a spatter, vacuum evaporationo, etc. is mentioned, since it is not necessary to distinguish by different color with in two colors rather than the case of the rotation particle 5, it is easy. About the latter, in case the polymerization of the outer shell is carried out, the coloring matter of the target color is mixed, and the approach of carrying out polymerization generation of the outer shell to which the color containing coloring matter was attached etc. is mentioned. In addition, as coloring matter which has the spectral characteristic in three primary colors, inorganic pigments, such as organic pigments, such as a perylene pigment, a lake pigment, azo pigment, the Quinacridone system pigment, an anthraquinone system pigment, metal replacement phthalocyanine pigment, and halogen multi-permutation phthalocyanine pigment, titanium oxide, ferrous oxide, cobalt purple, and cobalt blue, are mentioned.

[0038] Thus, the produced coloring microcapsule 1 is arranged on a base material 2 so that colors may differ periodically per pixel at random, and the display layer 3 is formed. When arranging at random, mixed distribution of the coloring microcapsule 1 of each color can be carried out at common resin solutions, such as acrylic, an methacrylic system, polyester, polystyrene, poly urea, a polyamide, and epoxy, spreading desiccation can be carried out on a base material 2, or a glue line can be prepared on a base material 2, and the display layer 3 can be formed by the approach of carrying out the cast of the coloring microcapsule 1 of each color distributed to the solvent. Of course about this formation approach, it is not limited. Even when the thickness of the display layer 3 is comparable as the particle size of a premise, then the coloring microcapsule 1 in forming a protective layer, a base material substrate, etc. on it, it is enough.

[0039] When arranging the coloring microcapsule 1 on the other hand so that colors may differ periodically per pixel, and forming the display layer 3, the photolithography method using the photoresist which distributed the coloring microcapsule 1 can be used. This approach arranges and fixes to a predetermined pixel the photoresist 11 which distributed the coloring microcapsule 1 of R according to a series of FOTORISO processes of spreading, desiccation, exposure, and development, as shown in drawing 4 . Then, according to the same FOTORISO process, the coloring microcapsule 1 of G and the coloring microcapsule 1 of B are arranged to a predetermined pixel one by one, and it fixes. In this case, since extent which fixes the coloring microcapsule 1 is enough as the photoresist layer which remains as a display layer 3, that thickness is comparable as the particle size of the coloring microcapsule 1, or less than [it] is desirable. This becomes possible by controlling the process conditions of FOTORISO. Moreover, although the negative resist which contained photopolymerization initiators, such as benzophenones and anthraquinone, for example to acrylate resin, or the positive resist which contained the esterification object of o-quinone diazide in novolak mold phenol resin can be used as a photoresist, what is necessary is just ** excellent in the adhesive property when not being limited to this and forming the dispersibility and the display layer 3 of the coloring microcapsule 1 with transparency etc.

[0040] As an approach of arranging the other coloring microcapsules 1 periodically per pixel, there is an electrochemical process etc. and an electrodeposition process, a micell electrolytic decomposition process, etc. are specifically mentioned. In the case of an electrochemical process, the conductive layer used as an electrode is needed for the part in which all form the

display layer 3. Therefore, although an electrode configuration which does not flow is needed between each pixel, the process of patterning arrangement of the coloring microcapsule 1 is easy. Moreover, when an electric means performs the roll control of a rotation particle, the electrode for forming a display layer can use as an electrode for a display drive as it is.
[0041] Drawing 5 shows the gestalt of 1 operation of the display sheet using the display layer 3 shown in drawing 1 , a protective layer 21 is formed in the display layer 3 bottom formed on the base material 2, and the memory layer 22 for holding display information is formed in the base material 2 bottom. A base material 2 is not especially limited, although resin films and resin plates, such as polyethylene terephthalate, a polycarbonate, and polyethylene, can be used. although the thinner one of the thickness is desirable when it takes performing writing/elimination into consideration, the thickness of a certain extent in consideration of the ease of treating as a sheet is required for it, and its about 10-1000 micrometers are desirable.
[0042] It is durable to the magnetic head, various press [in / further / real use], and friction, and transparency is high, a stable thing is used, and a protective layer 21 is formed by applying resin or making a resin film and a resin plate rival. Although the thinner one of the thickness is desirable from a viewpoint of visibility, when performing writing/elimination from the upper part, about 10-1000 micrometers is desirable on balance with the mechanical strength.
[0043] The memory layer 22 mainly consists of a semi-hard magnetic material, and the display information written in by the magnetic means can be held by magnetization of the memory layer 22, whether it cuts the field of writing or a certain amount of magnetic field exists in an operating environment. Although the thickness of the memory layer 22 is based also on the magnetic material and the production approach of using, its about 0.1-10 micrometers are desirable. The approach of setting up the threshold of particle rotation, in order to hold display information if needed, when there is no memory layer 22 can be considered.
[0044] As for the input section written in / eliminated, in the case of a display sheet, it is possible to separate and to make it become independent by the display. Therefore, it becomes the display means [handling / a means] like [it is light and] paper by using flexible ingredients, such as plastic film, about various components.
[0045] As a means to input or eliminate image information,-dimensional [1] or a two-dimensional magnetic-head array is used for the above-mentioned display sheet from the display layer 3 lower part, for example. Moreover, use of a magnetic pen etc. is attained from the upper part of the display layer 3 at a part of postscripts/elimination. In addition, in using a 1-dimensional magnetic-head array, it records the image of the whole viewing area using a means to move to a main scanning direction. When the display sheet is separated from such a writing/elimination means, alignment will be carried out to these, it will connect, and writing/elimination will be performed.
[0046] The gestalt of 1 operation of the display using the display layer 3 shown in drawing 1 is shown, the display which consists of a memory layer 22 the display layer 3, a protective layer 21, and if needed, and the input section which performs writing/elimination of the magnetic-head layer 23 etc. are united, and drawing 6 is formed on the base material 2. Although the above-mentioned display sheet was able to be separated from the input section and it was able to treat as a display medium like paper, this indicating equipment will be used as a display which fixed the installation. In this case, in order not to separate a display from the input section unlike a display sheet, it is not necessary to perform alignment of a display and the input section which performs writing/elimination, and becomes especially advantageous to color display.
[0047] Next, the display layer of the particle rotation mold by the electric means concerning the gestalt of operation of the 2nd of this invention is shown in drawing 7 . The coloring microcapsule 31 colored predetermined two or more colors (R), for example, red, green (G), or blue (B) is arranged by the gestalt of this operation on a base material 2 like the gestalt of the 1st operation, and the display layer 33 is formed. Unlike the gestalt of the 1st operation, the coloring microcapsule 31 has connoted the pivotable rotation particle 35 with the electric means. For this reason, with the gestalt of this operation, the rotation particle 35 is constituted so that it may have the electrification property that the parts kicked by two colors of light reflex nature and light absorption nature by the color differ, and as an electric means, per pixel, on both sides of

the display layer 33, the up electrode 36 and the lower electrode 37 are arranged so that electric field impression may be possible.

[0048] Also in the gestalt of this operation, the coloring microcapsule 31 with which colors differ is arranged at random. It sets up so that a rotational threshold may change with colors of the coloring microcapsule 31. The method of changing the magnitude of the electric field to impress and displaying the target color and the coloring microcapsule 31 can be changed periodically per pixel, a color can be arranged, and the approach of controlling the rotation condition of the rotation particle 35 per pixel, and displaying the target color etc. can be taken. The approach of arranging the coloring microcapsule 31 on a base material 2, and fixing is the same as that of the case of the gestalt of the 1st operation.

[0049] In the above-mentioned configuration, a different part from the gestalt of the 1st operation is explained. It is the particle which has the electrification property that the rotation particles 35 of the gestalt of this operation differ to being the particle in which the rotation particle 5 of the gestalt of the 1st operation had two magnetic poles. This is produced by covering a particle front face by matter different a semi-sphere every. That is, although a front face will usually be covered by the matter by which colors differ in case it classifies by color in two colors, it will give a different electrification property as it is. However, since it cannot necessarily contribute to particle rotation in fact, an ingredient which an electrification property is large and differ is added. Although the wax-like matter is well used for this from the ease of electrification control, waxes, such as higher-fatty-acid metal salts, such as higher fatty acids, such as stearin acid, a palmitic acid, and a lauric acid, and aluminum stearate, a higher-fatty-acid derivative, carnauba wax, and paraffin wax, polyethylene, polypropylene, an ethylene-vinylacetate copolymer, etc. are mentioned, for example. Moreover, although the rotation particle 35 can be connoted and used into a microcapsule as shown in drawing 2 like the rotation particle 5, dielectrics, such as a transparent silicone oil, are used for the fluid 6 in a microcapsule.

[0050] Moreover, by the color display method which controls a rotation particle by the electric means, as shown in drawing 7 , the up electrode 36 of the display layer 33 by which patterning was carried out up and down per pixel, and the lower electrode 37 are needed. Among these, the upside electrode 36 needs to be a transparent electrode. As this transparent electrode, well-known things, such as oxide-semiconductor thin films, such as In 2O3, SnO2, ZnO, CdO and TiO2, In2 O3-Sn, and SnO2-Sb, are used.

[0051] On the other hand, since the light which carried out incidence will reflect and return between the rotation particles 35 when [which is a transparent electrode] it sees from the top face of the display layer 33 if it is not required and an ingredient with the high rate of a light reflex is used rather, the display layer 33 can carry out improvement in brightness of the lower electrode 37. As a lower electrode 37, Au, Ag, Cu, Pt, aluminum, etc. are mentioned other than a transparent electrode.

[0052] The protective layer 21 is formed in the display layer 33 bottom formed on the base material 2 like the display sheet which drawing 8 shows the gestalt of 1 operation of the display sheet using the display layer 33 shown in drawing 7 , and is shown in drawing 5 . In this case, maintenance of display information is attained by the approach of setting up the threshold of particle rotation if needed. An ingredient suitable as the base material 5 and protective layer 21 of this display sheet is chosen like the case of the display sheet shown in drawing 5 . In addition, the gestalt which builds the electrode of the upper part of the display layer 33 and/or a lower electrode into sheet circles is also considered as a gestalt of other operations.

[0053] Drawing 9 shows the gestalt of 1 operation of the display using the display layer 33 shown in drawing 7 , and the display which consists of a display layer 33, and the input section which becomes this display layer 33 from the up electrodes 36 and 37 with which electric-field impression has been arranged possible at each pixel unit are united, it is formed on a base material 2, and the protective layer 21 is formed in the top face of the display layer 33 and the up electrode 36. Thus, since a display and the input section which performs writing/elimination are united, it is not necessary to perform alignment of a display and the input section like a display sheet, and is advantageous to especially color display.

[0054] In addition, although the particle rotation mold was mentioned as the example and the

gestalt of the above-mentioned implementation explained it, this invention can be applied also in the electrophoresis mold using a microcapsule, a magnetic migration mold, and a particulate material orientation mold, without being limited to this.

[0055]

[Example] Hereafter, the example of this invention is explained. In addition, an example 1 is equivalent to the gestalt of the 1st operation, and an example 2 is equivalent to the gestalt of the 2nd operation.

[0056] It is gamma-Fe 2O3 as the example 1 magnetic substance. It is Fe 3O4 as the polystyrene spherical particle containing a particle, and the magnetic substance. The polystyrene spherical particle containing a particle and the polystyrene spherical particle which contained the Fe4N particle as the magnetic substance were produced by the respectively well-known suspension-polymerization method. In addition, it was made for each particle size to be set to about 8 micrometers. These were pasted up so that the lower part of a particle might be buried on the glass substrate which attached the heat-resistant acrylic glue line, it carried out the spray coating cloth and magnetized in white the electromagnet of 1KG continuously with coloring liquid (titanium oxide / polyvinyl butyral / methyl ethyl ketone), the semi-sphere upper part was removed from the glue line, and the particle classified by color and magnetized by white / black 2 color was produced three kinds.

[0057] Next, the microcapsule which connoted the rotation particle and the silicone oil by the coacervation method of well-known gelatin and gum arabic was produced. Thus, according to the class of rotation particle which connoted the produced microcapsule, the dip painting cloth was carried out to the coloring liquid (perylene red / polyvinyl alcohol / water) of R, the coloring liquid (Phthalocyanine Green / polyvinyl alcohol / water) of G, and the coloring liquid (a copper phthalocyanine blue / polyvinyl alcohol / water) of B, respectively, it dried, and the microcapsule colored R, the microcapsule colored G, and the microcapsule colored B were obtained.

[0058] Next, after adding three kinds of coloring microcapsules, R, G, and B, tales doses every into the polyvinyl butyral / methyl-ethyl-ketone solution and fully mixing, on the 100-micrometer polycarbonate film, blade spreading was carried out, it dried, and the display layer which has arranged the coloring microcapsule of R, G, and B at random was produced. After applying the acrylic resin of a heat-curing mold on this display layer, 150 degrees C for 20 minutes, the 100-micrometer protective layer was formed, and the sheet for color displays was produced. In this sheet for a display, the threshold of the particle rotation in the coloring microcapsule of R was [the threshold of the particle rotation in about 15 gauss and the coloring microcapsule of B of the threshold of the particle rotation in about 5 gauss and the coloring microcapsule of G] about 30 gauss. When this sheet for a display was stuck to the two-dimensional magnetic-head array and writing/elimination was performed, the color display by color mixture was possible.

[0059] Carbon black was kneaded with example 2 Sun Wacks E-200 (Sanyo Chemical Industries make), it corned and classified by the spray dryer method, and about 15-micrometer black particle was produced. After producing the rotation particle which colored white the semi-sphere section and was classified by white / black 2 color by color by the same approach as an example 1 in this, it microencapsulated and was colored three kinds, R, G, and B. In addition, the example 1 of the rotation particle which differed and connoted the coloring microcapsule of every color is the same this time.

[0060] Next, the coloring microcapsule of R was distributed in the monomer solution (TOKYO OHKA KOGYO OMR-83) of a photo-curing mold transparence photopolymer, it applied on the 100-micrometer polycarbonate film with the spin coat method, and 90-degree C oven performed prebaking for 5 minutes. Complete exposure (400 mJ/cm2) of this was carried out with the ultrahigh pressure mercury lamp through the photo mask, the sodium-hydrogencarbonate water solution performed after a development, and 150-degree-C postbake for 30 minutes for 60 seconds at 25 degrees C 0.2%, and patterning arrangement of the coloring microcapsule of R was carried out at the position. Then, the display layer of about 15-micrometer thickness which arranges the coloring microcapsule of G similarly and finally arranges the coloring microcapsule of B and by which three kinds of coloring microcapsules, R, G, and B, have been arranged periodically at the 100x100-micrometer pixel was formed.

[0061] Thus, after applying the acrylic resin of a heat-curing mold on the produced display layer, 150 degrees C for 20 minutes, the 100-micrometer protective layer was formed, and the sheet for color displays was produced. When electric field were added to this sheet for a display with the electrode arranged to the display layer upper and lower sides and writing/elimination was performed, the color display by color mixture was possible.
[0062]
[Effect of the Invention] As described above, according to invention of claims 1-7, it is realizable with low cost with a configuration with the color display of a wide-field-of-view angle there is little fatigue of an eye because of a light-receiving mold, and comparatively easier than LCD.
[0063] Moreover, according to invention of claims 3, 10, and 14, the large simplification of the manufacture process of a display layer is realizable.
[0064] Moreover, according to invention of claims 4, 11, and 15, the controllability for color display can be made easy.
[0065] Moreover, according to invention of claims 8-12, the color display sheet of a wide-field-of-view angle can be obtained with an easy configuration, and a thin and flexible color display sheet can be produced like paper by low cost.
[0066] Moreover, according to invention of claims 13-16, there is little fatigue of an eye and it can realize the electrochromatic display of a wide-field-of-view angle by low cost with a comparatively easy configuration rather than LCD.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the display technique which carries out color display of the images, such as a graphic form and an alphabetic character.

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PRIOR ART

[Description of the Prior Art] As a display which displays information, although current [the viewpoint of the display quality and economical efficiency to] is in use as for CRT, various flat-panel displays are done [research and development in them] and put in practical use in consideration of small, the light weight, the low power, etc. As such a display, light-receiving mold displays, such as luminescence mold displays, such as a plasma display (PDP), an electroluminescence display (ELD), a fluorescent indicator tube (VFD), and a light emitting diode (LED), and a liquid crystal display (LCD), are mentioned.
[0003] Although the eye by flicker etc. is expected little display of fatigue since these get used and have so far been familiar with a medium called printed matter in OA field mainly applied, it is difficult to solve this point on luminescence mold displays including CRT. In that respect, although LCD of a light-receiving mold is advantageous and there are also advantages, such as a low power, the actual condition is that there are also characteristic demerits, such as an angle-of-visibility dependency and temperature dependence.
[0004] Then, it had the image display layer which a light-receiving mold display also becomes from a microcapsule, and magnetic or the method which performs image display, for example, an electrophoresis display, the magnetic migration display, the particulate material orientation mold display, the rotation particle mold display using electric or a magnetic means, etc. have been proposed by changing the rate of a light reflex per pixel by the electric action. With the microcapsule which connotes the liquid which distributed the particle of light absorption nature or light reflex nature, an electrophoresis display forms an image display layer and sets it to a microcapsule here. If an electric double layer is formed of transfer of the charge in a solid-liquid interface, a particle is charged in forward or negative and electric field are added to this, an image will be displayed using a particle migrating according to the direction of electric field by attaching the contrast of the light and darkness of the display layer upper part for every pixel.
[0005] Moreover, if a magnetic migration display forms an image display layer and a field is added with the microcapsule which connotes the liquid which distributed the magnetic-substance particle of light absorption nature, and the non-magnetic-material particle of light reflex nature, it will display an image using a magnetic-substance particle being attracted in a microcapsule by attaching the contrast of the light and darkness of the display layer upper part for every pixel.
[0006] Moreover, if a particulate material orientation mold display forms an image display layer and a field is added with the microcapsule which connotes the dispersion liquid of a magnetic-substance particle with shape anisotropy, such as flat nature, it will display an image using reflection of the light according to the sense of a magnetic-substance particle with shape anisotropy, dispersion, and absorption taking place by attaching the contrast of the light and darkness of the display layer upper part for every pixel.
[0007] Furthermore, a rotation particle mold display forms an image display layer with the microcapsule which connotes with a fluid the spherical rotation particle classified by every [a semi-sphere] by color, and is magnetic or a thing which displays an image by carrying out the roll control of the spherical rotation particle in a microcapsule, and attaching the contrast of the light and darkness of the display layer upper part for every pixel with an electric means etc.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] As described above, according to invention of claims 1-7, it is realizable with low cost with a configuration with the color display of a wide-field-of-view angle there is little fatigue of an eye because of a light-receiving mold, and comparatively easier than LCD.
[0063] Moreover, according to invention of claims 3, 10, and 14, the large simplification of the manufacture process of a display layer is realizable.
[0064] Moreover, according to invention of claims 4, 11, and 15, the controllability for color display can be made easy.
[0065] Moreover, according to invention of claims 8-12, the color display sheet of a wide-field-of-view angle can be obtained with an easy configuration, and a thin and flexible color display sheet can be produced like paper by low cost.
[0066] Moreover, according to invention of claims 13-16, there is little fatigue of an eye and it can realize the electrochromatic display of a wide-field-of-view angle by low cost with a comparatively easy configuration rather than LCD.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the present condition, these displays are only monochrome monochromatic specification and had the problem that color display was not put in practical use compared with CRT or LCD. For this reason, although what arranges the color filter of two or more colors, and performs color display on a display layer is proposed (JP,10-232630,A), since lamination becomes complicated, this influences display properties, such as brightness and contrast, a production process not only increases, but and its thickness increases also in the case of the writing/elimination from the display layer upper part when a color filter layer is added, it becomes disadvantageous while it can consider the cost rise by using a color filter.
[0009] This invention coped with the trouble of the above-mentioned conventional technique, was made, and it aims at magnetic or offering a display in the color display approach that color display can be performed, and the display sheet list using this color display approach, by easy control using the image display approach of changing the rate of a light reflex per pixel by the electric action, without complicating a configuration.

[Translation done.]

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MEANS

[Means for Solving the Problem] That is, the color display approach of invention of claim 1 is characterized by carrying out color display of the image by arranging two or more kinds of coloring microcapsules with which the surface color differs, controlling the condition of the particle by which endocyst was carried out to each coloring microcapsule, and changing the optical property of a coloring microcapsule.
[0011] In the color display approach of this invention, it is changing with the conditions of the particle which the rate of a light reflex of a coloring microcapsule connotes, and the surface color of a coloring microcapsule is displayed, or it becomes possible to make it display black, and the color display of an image becomes possible. Thereby, implementation of the color display of a wide-field-of-view angle is attained few from LCD by the fatigue of an eye by low cost with a comparatively easy configuration for a light-receiving mold.
[0012] Invention of claim 2 is characterized by the surface color of a coloring microcapsule being three kinds, red, green, and blue, in the color display approach of claim 1. Thereby, full color image display becomes possible in the combination of red, green, blue, and black.
[0013] In the color display approach of claim 1, invention of claim 3 sets up the control threshold to which the optical property of a coloring microcapsule is changed so that it may differ according to the class, it arranges two or more kinds of coloring microcapsules at random, changes the optical property of the coloring microcapsule of the target class alternatively, and is characterized by carrying out color display of the image. In this invention, the array of the coloring microcapsule with which colors differ is easy, without requiring the precise alignment of a display and the input section which performs writing/elimination, it is changing in the size of the magnetic operation impressed to a coloring microcapsule, or an electric action, and color display becomes possible.
[0014] In the color display approach of claim 1, invention of claim 4 arranges two or more kinds of coloring microcapsules so that classes may differ periodically per pixel, it changes the optical property of a coloring microcapsule per pixel, and is characterized by carrying out color display of the image. It is not necessary to change the control threshold to which the optical property of a coloring microcapsule is changed according to that class, and color display becomes possible easily by control of a pixel unit in this invention.
[0015] In the color display approach of claim 1, a coloring microcapsule connotes the particle classified by two colors of light reflex nature and light absorption nature by color pivotable, and invention of claim 5 is characterized by changing the optical property of a coloring microcapsule according to the rotation condition of this particle. When the surface color of the coloring microcapsule which connoted this rotation particle by this when the field of the light reflex nature of a rotation particle was turned to a side front is displayed and the field of light absorption nature is turned to a side front, black is displayed and the color display of an image becomes possible.
[0016] Invention of claim 6 is characterized by a coloring microcapsule connoting a pivotable particle according to a magnetic operation in the color display approach of claim 5. This becomes possible to control the rotation condition of a particle by magnetic means, such as the magnetic head, and color display which excelled [configuration / easy] in visibility is realized.

[0017] Invention of claim 7 is characterized by a coloring microcapsule connoting a pivotable particle by the electric action in the color display approach of claim 5. Thereby, the rotation condition of the particle in a coloring microcapsule can be easily controlled using the electric-field impression drive method by the pixel electrode, and color display of high resolution is realized.
[0018] The display sheet of invention of claim 8 is characterized by having the display layer in which two or more kinds of coloring microcapsules with which the surface color from which an optical property changes with the conditions of the particle to connote differs were arranged. In this invention, it becomes possible by controlling the condition of the particle in a coloring microcapsule and changing the optical property of the target coloring microcapsule to display an image in a color easily. Moreover, since the configuration is easy as a display sheet, the color display sheet of a thin and flexible wide-field-of-view angle is obtained like paper, and it becomes producible by low cost.
[0019] Invention of claim 9 is characterized by the surface color of a coloring microcapsule being three kinds, red, green, and blue, in the display sheet of claim 8. Thereby, full color image display becomes possible in the combination of red, green, blue, and black.
[0020] In the display sheet of claim 8, the control thresholds to which the optical property of a coloring microcapsule is changed differ according to a class, and invention of claim 10 is characterized by arranging two or more kinds of coloring microcapsules at random. without requiring the precise alignment of a display sheet and an input means to perform writing/elimination, while the array of the coloring microcapsule with which colors differ is easy and comes out in this invention, it is changing in the size of the magnetic operation impressed to a coloring microcapsule, or an electric action, and color display becomes possible.
[0021] Invention of claim 11 is characterized by for two or more kinds of coloring microcapsules changing a class periodically per pixel, and arranging them in the display sheet of claim 8. It is not necessary to change the control threshold to which the optical property of a coloring microcapsule is changed according to that class, and color display becomes possible easily by control of a pixel unit in this invention.
[0022] Invention of claim 12 connotes the particle by which the coloring microcapsule was classified by two colors of light reflex nature and light absorption nature by color pivotable in the display sheet of claim 8, and the rotation condition of this particle is characterized by the controllable thing with a magnetic means or an electric means. In this invention with magnetic means, such as the magnetic head, or the electric means of a pixel electrode etc. When the rotation condition of the particle in the coloring microcapsule of a display sheet can be controlled and the field of the light reflex nature of a rotation particle is turned to a side front When the surface color of the coloring microcapsule which connoted this rotation particle is displayed and the field of light absorption nature is turned to a side front, black is displayed and the color display of an image becomes possible.
[0023] The display of invention of claim 13 is characterized by having the display layer in which two or more kinds of coloring microcapsules with which the surface color from which an optical property changes with the conditions of the particle to connote differs were arranged, and an input means to control the particle condition in a coloring microcapsule per pixel of a display layer, and to perform the writing or elimination of an image. In this invention, it is that an input means controls the particle condition in the coloring microcapsule of a display layer per pixel, and display selection of the surface color of a coloring microcapsule or black is made, and color display of an image thru/or elimination are performed easily.
[0024] In the display of claim 13, the control thresholds to which the optical property of a coloring microcapsule is changed differ according to a class, and invention of claim 14 is characterized by arranging two or more kinds of coloring microcapsules at random. In this invention, the array of the coloring microcapsule with which colors differ is easy, and is changing in the size of the magnetic operation impressed to a coloring microcapsule, or an electric action, and the color display of it becomes possible.
[0025] Invention of claim 15 is characterized by for two or more kinds of coloring microcapsules changing a class periodically per pixel, and arranging them in the display of claim 13. It is not

necessary to change the control threshold to which the optical property of a coloring microcapsule is changed according to that class, and color display becomes possible easily by control of a pixel unit in this invention.

[0026] Invention of claim 16 is characterized by the optical property of a coloring microcapsule changing with the rotation conditions of the particle to connote in the display of claim 13. In this invention, by controlling the rotation condition of the particle in a coloring microcapsule by the magnetic means or the electric means, display selection of the surface color of a coloring microcapsule or black is made, and color display of an image thru/or elimination are performed easily.

[0027]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. Drawing 1 shows the display layer of the particle rotation mold by the magnetic means concerning the gestalt of operation of the 1st of this invention, the coloring microcapsule 1 colored separately at predetermined two or more colors (R), for example, red, green (G), or blue (B) is arranged on a base material 2, and the display layer 3 is formed. As shown in drawing 2 , the endocyst of the rotation particle 5 classified by two colors of light reflex nature like white/black and light absorption nature by color is carried out to the colored outer shell 4 with a fluid 6, and the coloring microcapsule 1 is constituted so that the rotation particle 5 can rotate freely within a capsule. When the rotation particle 5 contains the magnetic substance, a roll control is carried out by the magnetic means of magnetic-head 7 grade per pixel and the white of light reflex nature becomes a side front, the color of the coloring microcapsule 1 is observed, and black is observed when the black of light absorption nature becomes a side front.

[0028] The method of arranging at random the coloring microcapsule 1 with which colors differ first, setting up so that a rotational threshold may change with colors of the coloring microcapsule 1, changing the magnitude of the magnetic field to impress, and displaying the target color is mentioned as an approach of performing color display in such a display layer 3. The threshold of rotation of the coloring microcapsule 1 can be adjusted to arbitration by changing the factor which influences rotation of the content of the magnetic substance in the rotation particle 5, the viscosity of the fluid 6 in a class or the coloring microcapsule 1, etc.

[0029] An example is given and this color display approach is explained using drawing 3 . As shown in drawing 3 (a), each coloring microcapsule 1 of R, G, and B which are arranged at random shall have 5 and the rotation threshold which is 15 or 30 gauss on a base material 2, respectively. In this case, if a 10 gauss magnetic field is added, since the roll control of the rotation particle 5 only of the coloring microcapsule 1 of R will become possible, as shown in drawing 3 (b), R can be displayed by carrying out the roll control of the semi-sphere part with the higher rate of a light reflex (white) to a side front in a 10 gauss magnetic field. Moreover, if a 20 gauss magnetic field is added, since the roll control of the rotation particle 5 of the coloring microcapsule 1 of G will become possible, G can be displayed by carrying out the roll control of the rotation particle 5 in a capsule in a 20 gauss magnetic field so that the one (white) where the rate of a light reflex is higher may serve as a side front. However, since R is also displayed on coincidence at this time, when the display of R is unnecessary, a 10 gauss magnetic field is continuously added to hard flow, and only the rotation particle 5 of the coloring microcapsule 1 of R makes a side front the one (black) where the rate of a light reflex is lower. After similarly carrying out the roll control of the rotation particle 5 in the coloring microcapsule 1 of R, G, and B in a 30 gauss magnetic field and making into a side front the one (white) where the rate of a light reflex is higher, only B can be displayed by carrying out the roll control of the rotation particle 5 in the coloring microcapsule 1 of R and G in a 20 gauss magnetic field, and making into a side front the one (black) where the rate of a light reflex is lower.

[0030] Thus, the target color can be displayed with the magnitude of the magnetic field to impress. It is not necessary to arrange the coloring microcapsule 1 with which colors differ per pixel by this color display approach, and there is no need for the precise alignment of a display and the input section which performs writing/elimination.

[0031] Moreover, as the approach of other color displays, the coloring microcapsule 1 is arranged

so that colors may differ periodically per pixel, and there is the approach of controlling the rotation condition of the rotation particle 5 per pixel. In this case, it is not necessary to change the rotation threshold of the coloring microcapsule 1 according to a color.
[0032] the above -- if any approach makes the color of the coloring microcapsule 1 three kinds, R, G, and B, the expression of neutral colors will also be attained in the combination of R, G, and B which can express R, G, B, and black as it is, can express white with color mixture if all of R, adjacent G, and adjacent B are made to color, and are made to color. However, about gradation, it is difficult and it is realistic to make a pixel small and to perform area gradation what is depended on rotation condition.
[0033] Next, each component and the manufacture approach of a gestalt of this operation are explained. As mentioned above, the coloring microcapsule 1 has a configuration as shown in drawing 2 , and the rotation particle 5 can rotate it now freely within a capsule with a fluid 6. Although the magnitude of the coloring microcapsule 1 is related to the ease of carrying out of the magnitude (resolution) of a display and a display pixel, dispersion of light, and manufacture etc., its about 1-1000 micrometers are practical.
[0034] The rotation particle 5 contains the magnetic substance, it is magnetized so that it might be classified by two colors by color, while N pole and another side may become the south pole in them, and it serves as a permanent magnet. The magnetic substance / resin system particle to which the rotation particle 5 made resin, such as a particle of the magnetic substance or polystyrene, and polyethylene, contain the magnetic substance, such as magnetite, iron like a ferrite, cobalt, and nickel, are used. Rotation of a particle and control of a halt are easy for the gestalt of the rotation particle 5, and it is desirable, and since what has a uniform configuration and magnitude is desired, it is substantially desirable. [of the shape of a ball] [of the easy thing of classification by color and manufacture] Furthermore, specific gravity, chemical stability, etc. are important. the monomer which ground it after especially the magnetic substance / resin system particle kneaded these, or distributed the magnetic-substance particle -- an emulsion polymerization and a suspension polymerization -- or a distributed polymerization can be carried out and it can produce.
[0035] In order to color the rotation particle 5 with the color of light reflex nature, or the color of light absorption nature, it can apply with a spray etc., or can cover with electrochemical processes, such as plating, or the approach of distributing the coloring matter of black systems, such as coloring matter of white systems, such as a titanium dioxide, or carbon, to binder resin a solvent and if needed, and putting metals, such as the above-mentioned coloring matter, and Au, Ag, aluminum, by the spatter, vacuum evaporationo, etc. can be used. Moreover, in order to distinguish by different color with in two colors, embed a non-coloring field in adhesives or a resin layer, and it fixes, or is colored only an exposure by floating into the liquid which adjusted specific gravity etc. Since the color of the magnetic substance is almost black when the rotation particle 5 is a magnetic-substance particle, when using black for one side between two colors, it can classify by color in two colors only by coloring white another side. In the color display of this invention, since it is colored the outer shell of a microcapsule, the rotation particle in monochrome display can be used as it is.
[0036] independent [in common resin, such as acrylic, an methacrylic system, polyester, polystyrene, poly urea, a polyamide, and epoxy,] as an ingredient which forms the outer shell 4 of the coloring microcapsule 1 -- or it can be mixed and used. As the manufacture approach of a microcapsule, the in-situ method which supplies a monomer from one side of the internal phase of an emulsion or external phase who distributed the interfacial polymerization which supplies a monomer, and the rotation particle 3, or a microencapsulation technique well-known in addition to this can be used from both the inside of an emulsion which distributed the rotation particle 5, and an outside. Properties, such as a mechanical strength which is equal to a certain amount of press, and transparency, chemical stability, are searched for, and the outer shell 4 of a microcapsule can also be reinforced by surface treatment, such as covering a front face by various resin etc. if needed. Moreover, the fluid 6 in the coloring microcapsule 1 is most asked for the lubrication action for making rotation of the rotation particle 5 smooth, and it can use liquids, such as water, an oil, and alcohol, for it.

[0037] As the coloring approach of these microcapsules, there is an approach of coloring after microcapsule production or the approach of producing the outer shell which had the target color from the beginning. Although the approach of putting by electrochemical processes which distribute coloring matter particles, such as R, G, and B, to binder resin a solvent and if needed, and are applied with a spray etc. about the former, such as an approach and plating, a spatter, vacuum evaporationo, etc. is mentioned, since it is not necessary to distinguish by different color with in two colors rather than the case of the rotation particle 5, it is easy. About the latter, in case the polymerization of the outer shell is carried out, the coloring matter of the target color is mixed, and the approach of carrying out polymerization generation of the outer shell to which the color containing coloring matter was attached etc. is mentioned. In addition, as coloring matter which has the spectral characteristic in three primary colors, inorganic pigments, such as organic pigments, such as a perylene pigment, a lake pigment, azo pigment, the Quinacridone system pigment, an anthraquinone system pigment, metal replacement phthalocyanine pigment, and halogen multi-permutation phthalocyanine pigment, titanium oxide, ferrous oxide, cobalt purple, and cobalt blue, are mentioned.

[0038] Thus, the produced coloring microcapsule 1 is arranged on a base material 2 so that colors may differ periodically per pixel at random, and the display layer 3 is formed. When arranging at random, mixed distribution of the coloring microcapsule 1 of each color can be carried out at common resin solutions, such as acrylic, an methacrylic system, polyester, polystyrene, poly urea, a polyamide, and epoxy, spreading desiccation can be carried out on a base material 2, or a glue line can be prepared on a base material 2, and the display layer 3 can be formed by the approach of carrying out the cast of the coloring microcapsule 1 of each color distributed to the solvent. Of course about this formation approach, it is not limited. Even when the thickness of the display layer 3 is comparable as the particle size of a premise, then the coloring microcapsule 1 in forming a protective layer, a base material substrate, etc. on it, it is enough.

[0039] When arranging the coloring microcapsule 1 on the other hand so that colors may differ periodically per pixel, and forming the display layer 3, the photolithography method using the photoresist which distributed the coloring microcapsule 1 can be used. This approach arranges and fixes to a predetermined pixel the photoresist 11 which distributed the coloring microcapsule 1 of R according to a series of FOTORISO processes of spreading, desiccation, exposure, and development, as shown in drawing 4 . Then, according to the same FOTORISO process, the coloring microcapsule 1 of G and the coloring microcapsule 1 of B are arranged to a predetermined pixel one by one, and it fixes. In this case, since extent which fixes the coloring microcapsule 1 is enough as the photoresist layer which remains as a display layer 3, that thickness is comparable as the particle size of the coloring microcapsule 1, or less than [it] is desirable. This becomes possible by controlling the process conditions of FOTORISO. Moreover, although the negative resist which contained photopolymerization initiators, such as benzophenones and anthraquinone, for example to acrylate resin, or the positive resist which contained the esterification object of o-quinone diazide in novolak mold phenol resin can be used as a photoresist, what is necessary is just ** excellent in the adhesive property when not being limited to this and forming the dispersibility and the display layer 3 of the coloring microcapsule 1 with transparency etc.

[0040] As an approach of arranging the other coloring microcapsules 1 periodically per pixel, there is an electrochemical process etc. and an electrodeposition process, a micell electrolytic decomposition process, etc. are specifically mentioned. In the case of an electrochemical process, the conductive layer used as an electrode is needed for the part in which all form the display layer 3. Therefore, although an electrode configuration which does not flow is needed between each pixel, the process of patterning arrangement of the coloring microcapsule 1 is easy. Moreover, when an electric means performs the roll control of a rotation particle, the electrode for forming a display layer can use as an electrode for a display drive as it is.

[0041] Drawing 5 shows the gestalt of 1 operation of the display sheet using the display layer 3 shown in drawing 1 , a protective layer 21 is formed in the display layer 3 bottom formed on the base material 2, and the memory layer 22 for holding display information is formed in the base

material 2 bottom. A base material 2 is not especially limited, although resin films and resin plates, such as polyethylene terephthalate, a polycarbonate, and polyethylene, can be used. although the thinner one of the thickness is desirable when it takes performing writing/elimination into consideration, the thickness of a certain extent in consideration of the ease of treating as a sheet is required for it, and its about 10-1000 micrometers are desirable.
[0042] It is durable to the magnetic head, various press [in / further / real use], and friction, and transparency is high, a stable thing is used, and a protective layer 21 is formed by applying resin or making a resin film and a resin plate rival. Although the thinner one of the thickness is desirable from a viewpoint of visibility, when performing writing/elimination from the upper part, about 10-1000 micrometers is desirable on balance with the mechanical strength.
[0043] The memory layer 22 mainly consists of a semi-hard magnetic material, and the display information written in by the magnetic means can be held by magnetization of the memory layer 22, whether it cuts the field of writing or a certain amount of magnetic field exists in an operating environment. Although the thickness of the memory layer 22 is based also on the magnetic material and the production approach of using, its about 0.1-10 micrometers are desirable. The approach of setting up the threshold of particle rotation, in order to hold display information if needed, when there is no memory layer 22 can be considered.
[0044] As for the input section written in / eliminated, in the case of a display sheet, it is possible to separate and to make it become independent by the display. Therefore, it becomes the display means [handling / a means] like [it is light and] paper by using flexible ingredients, such as plastic film, about various components.
[0045] As a means to input or eliminate image information,-dimensional [1] or a two-dimensional magnetic-head array is used for the above-mentioned display sheet from the display layer 3 lower part, for example. Moreover, use of a magnetic pen etc. is attained from the upper part of the display layer 3 at a part of postscripts/elimination. In addition, in using a 1-dimensional magnetic-head array, it records the image of the whole viewing area using a means to move to a main scanning direction. When the display sheet is separated from such a writing/elimination means, alignment will be carried out to these, it will connect, and writing/elimination will be performed.
[0046] The gestalt of 1 operation of the display using the display layer 3 shown in drawing 1 is shown, the display which consists of a memory layer 22 the display layer 3, a protective layer 21, and if needed, and the input section which performs writing/elimination of the magnetic-head layer 23 etc. are united, and drawing 6 is formed on the base material 2. Although the above-mentioned display sheet was able to be separated from the input section and it was able to treat as a display medium like paper, this indicating equipment will be used as a display which fixed the installation. In this case, in order not to separate a display from the input section unlike a display sheet, it is not necessary to perform alignment of a display and the input section which performs writing/elimination, and becomes especially advantageous to color display.
[0047] Next, the display layer of the particle rotation mold by the electric means concerning the gestalt of operation of the 2nd of this invention is shown in drawing 7 . The coloring microcapsule 31 colored predetermined two or more colors (R), for example, red, green (G), or blue (B) is arranged by the gestalt of this operation on a base material 2 like the gestalt of the 1st operation, and the display layer 33 is formed. Unlike the gestalt of the 1st operation, the coloring microcapsule 31 has connoted the pivotable rotation particle 35 with the electric means. For this reason, with the gestalt of this operation, the rotation particle 35 is constituted so that it may have the electrification property that the parts kicked by two colors of light reflex nature and light absorption nature by the color differ, and as an electric means, per pixel, on both sides of the display layer 33, the up electrode 36 and the lower electrode 37 are arranged so that electric field impression may be possible.
[0048] Also in the gestalt of this operation, the coloring microcapsule 31 with which colors differ is arranged at random. It sets up so that a rotational threshold may change with colors of the coloring microcapsule 31. The method of changing the magnitude of the electric field to impress and displaying the target color and the coloring microcapsule 31 can be changed periodically per pixel, a color can be arranged, and the approach of controlling the rotation condition of the

rotation particle 35 per pixel, and displaying the target color etc. can be taken. The approach of arranging the coloring microcapsule 31 on a base material 2, and fixing is the same as that of the case of the gestalt of the 1st operation.

[0049] In the above-mentioned configuration, a different part from the gestalt of the 1st operation is explained. It is the particle which has the electrification property that the rotation particles 35 of the gestalt of this operation differ to being the particle in which the rotation particle 5 of the gestalt of the 1st operation had two magnetic poles. This is produced by covering a particle front face by matter different a semi-sphere every. That is, although a front face will usually be covered by the matter by which colors differ in case it classifies by color in two colors, it will give a different electrification property as it is. However, since it cannot necessarily contribute to particle rotation in fact, an ingredient which an electrification property is large and differ is added. Although the wax-like matter is well used for this from the ease of electrification control, waxes, such as higher-fatty-acid metal salts, such as higher fatty acids, such as stearin acid, a palmitic acid, and a lauric acid, and aluminum stearate, a higher-fatty-acid derivative, carnauba wax, and paraffin wax, polyethylene, polypropylene, an ethylene-vinylacetate copolymer, etc. are mentioned, for example. Moreover, although the rotation particle 35 can be connoted and used into a microcapsule as shown in drawing 2 like the rotation particle 5, dielectrics, such as a transparent silicone oil, are used for the fluid 6 in a microcapsule.

[0050] Moreover, by the color display method which controls a rotation particle by the electric means, as shown in drawing 7 , the up electrode 36 of the display layer 33 by which patterning was carried out up and down per pixel, and the lower electrode 37 are needed. Among these, the upside electrode 36 needs to be a transparent electrode. As this transparent electrode, well-known things, such as oxide-semiconductor thin films, such as In 2O3, SnO2, ZnO, CdO and TiO2, In2 O3-Sn, and SnO2-Sb, are used.

[0051] On the other hand, since the light which carried out incidence will reflect and return between the rotation particles 35 when [which is a transparent electrode] it sees from the top face of the display layer 33 if it is not required and an ingredient with the high rate of a light reflex is used rather, the display layer 33 can carry out improvement in brightness of the lower electrode 37. As a lower electrode 37, Au, Ag, Cu, Pt, aluminum, etc. are mentioned other than a transparent electrode.

[0052] The protective layer 21 is formed in the display layer 33 bottom formed on the base material 2 like the display sheet which drawing 8 shows the gestalt of 1 operation of the display sheet using the display layer 33 shown in drawing 7 , and is shown in drawing 5 . In this case, maintenance of display information is attained by the approach of setting up the threshold of particle rotation if needed. An ingredient suitable as the base material 5 and protective layer 21 of this display sheet is chosen like the case of the display sheet shown in drawing 5 . In addition, the gestalt which builds the electrode of the upper part of the display layer 33 and/or a lower electrode into sheet circles is also considered as a gestalt of other operations.

[0053] Drawing 9 shows the gestalt of 1 operation of the display using the display layer 33 shown in drawing 7 , and the display which consists of a display layer 33, and the input section which becomes this display layer 33 from the up electrodes 36 and 37 with which electric-field impression has been arranged possible at each pixel unit are united, it is formed on a base material 2, and the protective layer 21 is formed in the top face of the display layer 33 and the up electrode 36. Thus, since a display and the input section which performs writing/elimination are united, it is not necessary to perform alignment of a display and the input section like a display sheet, and is advantageous to especially color display.

[0054] In addition, although the particle rotation mold was mentioned as the example and the gestalt of the above-mentioned implementation explained it, this invention can be applied also in the electrophoresis mold using a microcapsule, a magnetic migration mold, and a particulate material orientation mold, without being limited to this.

[Translation done.]

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EXAMPLE

[Example] Hereafter, the example of this invention is explained. In addition, an example 1 is equivalent to the gestalt of the 1st operation, and an example 2 is equivalent to the gestalt of the 2nd operation.
[0056] It is gamma-Fe 2O3 as the example 1 magnetic substance. It is Fe 3O4 as the polystyrene spherical particle containing a particle, and the magnetic substance. The polystyrene spherical particle containing a particle and the polystyrene spherical particle which contained the Fe4N particle as the magnetic substance were produced by the respectively well-known suspension-polymerization method. In addition, it was made for each particle size to be set to about 8 micrometers. These were pasted up so that the lower part of a particle might be buried on the glass substrate which attached the heat-resistant acrylic glue line, it carried out the spray coating cloth and magnetized in white the electromagnet of 1KG continuously with coloring liquid (titanium oxide / polyvinyl butyral / methyl ethyl ketone), the semi-sphere upper part was removed from the glue line, and the particle classified by color and magnetized by white / black 2 color was produced three kinds.
[0057] Next, the microcapsule which connoted the rotation particle and the silicone oil by the coacervation method of well-known gelatin and gum arabic was produced. Thus, according to the class of rotation particle which connoted the produced microcapsule, the dip painting cloth was carried out to the coloring liquid (perylene red / polyvinyl alcohol / water) of R, the coloring liquid (Phthalocyanine Green / polyvinyl alcohol / water) of G, and the coloring liquid (a copper phthalocyanine blue / polyvinyl alcohol / water) of B, respectively, it dried, and the microcapsule colored R, the microcapsule colored G, and the microcapsule colored B were obtained.
[0058] Next, after adding three kinds of coloring microcapsules, R, G, and B, tales doses every into the polyvinyl butyral / methyl-ethyl-ketone solution and fully mixing, on the 100-micrometer polycarbonate film, blade spreading was carried out, it dried, and the display layer which has arranged the coloring microcapsule of R, G, and B at random was produced. After applying the acrylic resin of a heat-curing mold on this display layer, 150 degrees C for 20 minutes, the 100-micrometer protective layer was formed, and the sheet for color displays was produced. In this sheet for a display, the threshold of the particle rotation in the coloring microcapsule of R was [the threshold of the particle rotation in about 15 gauss and the coloring microcapsule of B of the threshold of the particle rotation in about 5 gauss and the coloring microcapsule of G] about 30 gauss. When this sheet for a display was stuck to the two-dimensional magnetic-head array and writing/elimination was performed, the color display by color mixture was possible.
[0059] Carbon black was kneaded with example 2 Sun Wacks E-200 (Sanyo Chemical Industries make), it corned and classified by the spray dryer method, and about 15-micrometer black particle was produced. After producing the rotation particle which colored white the semi-sphere section and was classified by white / black 2 color by color by the same approach as an example 1 in this, it microencapsulated and was colored three kinds, R, G, and B. In addition, the example 1 of the rotation particle which differed and connoted the coloring microcapsule of every color is the same this time.
[0060] Next, the coloring microcapsule of R was distributed in the monomer solution (TOKYO OHKA KOGYO OMR-83) of a photo-curing mold transparence photopolymer, it applied on the

100-micrometer polycarbonate film with the spin coat method, and 90-degree C oven performed prebaking for 5 minutes. Complete exposure (400 mJ/cm2) of this was carried out with the ultrahigh pressure mercury lamp through the photo mask, the sodium-hydrogencarbonate water solution performed after a development, and 150-degree-C postbake for 30 minutes for 60 seconds at 25 degrees C 0.2%, and patterning arrangement of the coloring microcapsule of R was carried out at the position. Then, the display layer of about 15-micrometer thickness which arranges the coloring microcapsule of G similarly and finally arranges the coloring microcapsule of B and by which three kinds of coloring microcapsules, R, G, and B, have been arranged periodically at the 100x100-micrometer pixel was formed.

[0061] Thus, after applying the acrylic resin of a heat-curing mold on the produced display layer, 150 degrees C for 20 minutes, the 100-micrometer protective layer was formed, and the sheet for color displays was produced. When electric field were added to this sheet for a display with the electrode arranged to the display layer upper and lower sides and writing/elimination was performed, the color display by color mixture was possible.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the display layer of the particle rotation mold by the magnetic means concerning the gestalt of operation of the 1st of this invention.
[Drawing 2] It is drawing showing the configuration of a microcapsule.
[Drawing 3] It is drawing showing the example of color display by the threshold magnetic field.
[Drawing 4] It is drawing showing the example of an arrangement process of the coloring microcapsule by the photolithography method.
[Drawing 5] It is the sectional view showing the gestalt of 1 operation of the display sheet using the display layer shown in drawing 1 .
[Drawing 6] It is the sectional view showing the gestalt of 1 operation of the display using the display layer shown in drawing 1 .
[Drawing 7] It is the sectional view showing the display layer of the particle rotation mold by the electric means concerning the gestalt of operation of the 2nd of this invention.
[Drawing 8] It is the sectional view showing the gestalt of 1 operation of the display sheet using the display layer shown in drawing 7 .
[Drawing 9] It is the sectional view showing the gestalt of 1 operation of the display using the display layer shown in drawing 7 .
[Description of Notations]
1 31 .... Coloring microcapsule
2 .... Base material
3 33 .... Display layer
4 .... Outer shell
5 35 .... Rotation particle
6 .... Fluid
7 .... Magnetic head
21 .... Protective layer
22 .... Memory layer
23 .... Magnetic-head layer
36 .... Up electrode
37 .... Lower electrode

[Translation done.]

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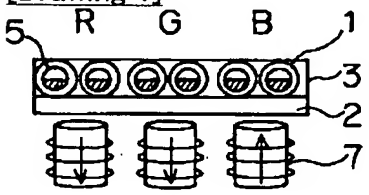
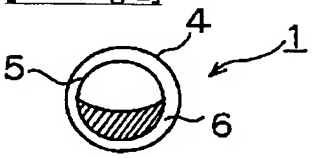
DRAWINGS

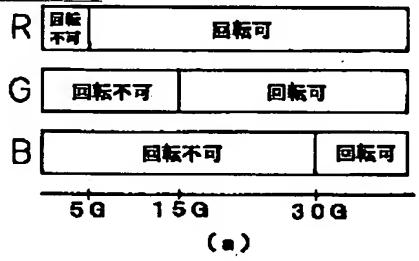
[Drawing 1]



[Drawing 2]



[Drawing 3]



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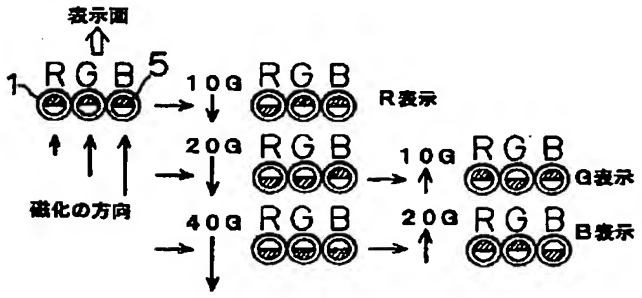
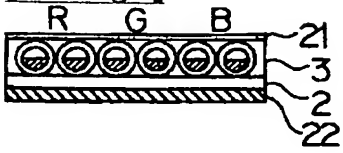


(b)

[Drawing 5]



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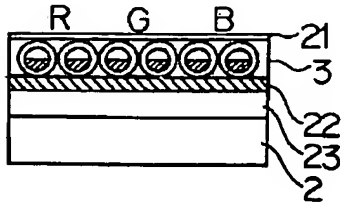
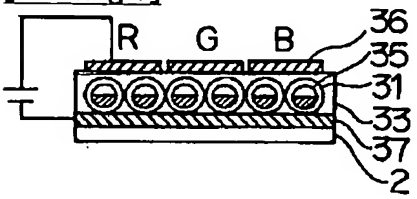
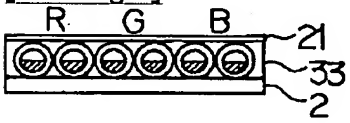


[Drawing 7]



[Drawing 8]



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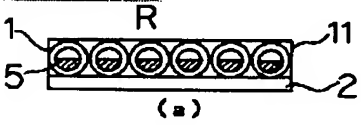
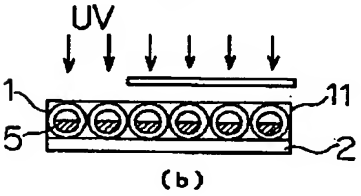
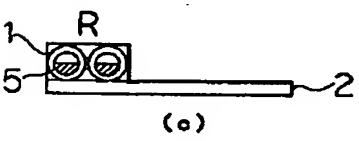
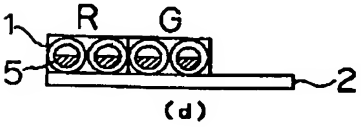
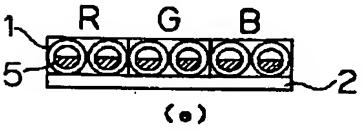


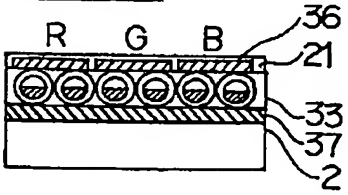








[Drawing 9]



[Translation done.]